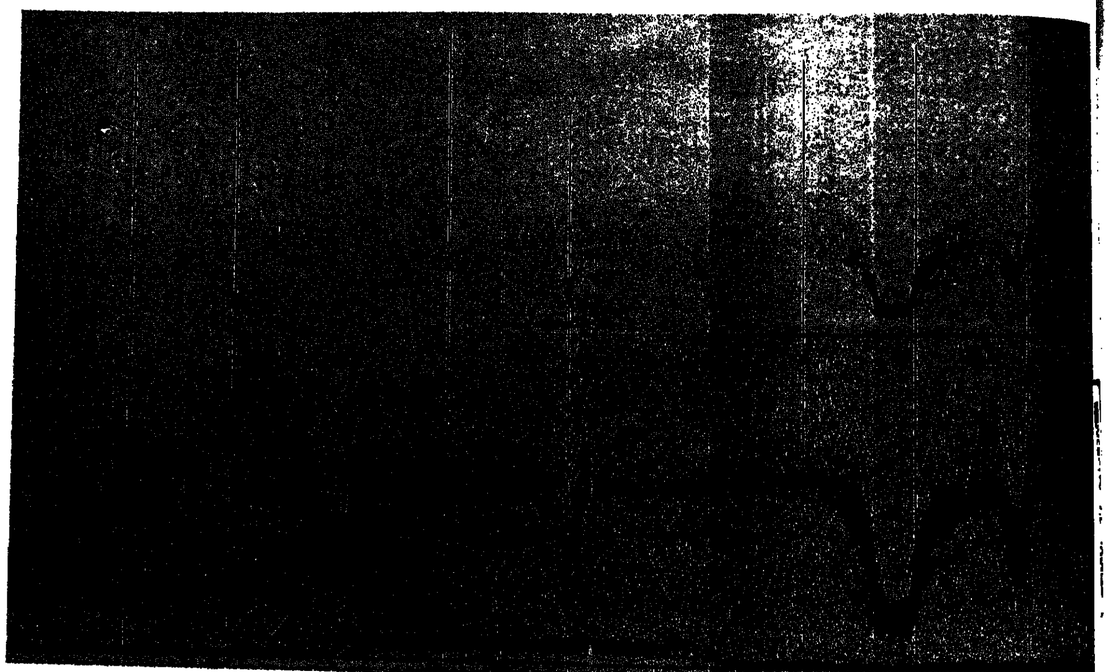

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Particles and Fields—Ionosphere

5510 Ion densities and temperatures
A THEORETICAL E-REGION STUDY OF ION COMPOSITIONAL AND TEMPERATURE VARIATIONS IN RESPONSE TO MAGNETOSPHERIC STORM INPUTS
J. J. Sojka (Center for Atmospheric and Space Sciences, Utah State University, Logan, Utah 84322), and R. W. Schunk

The response of the polar ionosphere to magnetospheric storm inputs was modeled. During the "storm", the spatial extent of the auroral oval, the intensity of the precipitating auroral electron energy flux, and the plasma convection pattern were varied with time. The convection pattern changed from a symmetric two-cell pattern with enhanced plasma flow in the dusk sector and a total cross-tail potential of 90 kV. During the storm there were significant changes in the ion temperature, ion composition, and molecular/atomic ion transition height. The streamline asymmetric convection pattern produced an ion temperature hot spot at the location of the dusk convection cell owing to increased ion-neutral frictional heating. In this hot spot there were significantly enhanced NO^+ densities, and hence, molecular/atomic ion transition heights. During the storm recovery phase, the decay of the enhanced NO^+ density closely followed the decrease in the plasma convection speed. During the storm, elevated ion temperatures also appeared at high altitudes in the midnight-dawn auroral region. These elevated ion temperatures were a consequence of the storm-enhanced topside O^+ densities, which provided better thermal coupling to the hot electrons. This region also contained reduced molecular/atomic ion transition heights. These elevated ion temperature and reduced transition heights persisted for several hours after the storm main phase ended.
J. Geophys. Res., A, Paper 4A0033

5543 Ion densities and temperatures
SATURN'S IONOSPHERE: INFRARED ELECTRON DENSITIES
N. L. Baker, K. D. Beach, J. E. P. Connerney (Laboratory for Extraterrestrial Physics, NASA Goddard Space Flight Center, Greenbelt, MD 20771)

During the two Voyager encounters with Saturn, radio bursts were detected which appear to have originated from atmospheric lightning storms. Although these bursts generally occur with power densities from as low as 100 mW to the upper detection limit of the instrument, 40 MHz, they often exhibited a sharp but variable low frequency cutoff below which bursts were not detected. We interpret the variable low-frequency extinction of these bursts to be due to the refraction and reflection of the radio waves as they propagate through an ionosphere which varies with local time. We obtain electron densities at a variety of latitudes and local time locations. These compare well with the order-of-magnitude diurnal variation of electron density, which had not been anticipated by theoretical models of Saturn's ionosphere, and an equally drastic extinction of ionospheric electron density by Saturn's rings. (Saturn, electron density, Ionosphere).
J. Geophys. Res., A, Paper 4A0051

5560 Particle precipitation
AVERAGE ELECTRON PRECIPITATION PATTERNS AND VISUAL AURORAL CHARACTERISTICS DURING GEOMAGNETIC QUIESCENCE
T. Sabbah (CNRS/ARPA, Lannion, Lannion, 22702) and C.-I. Meng

The pattern of polar-region, electron precipitation during geomagnetically quiet periods (i.e., quietly under of moderate activity) is studied on the basis of satellite fragments from the Defense Meteorological Satellite Program F5, F7, and F8 satellites. The auroral electron precipitation during quiet times consists of diffuse zones that differ from those found in active times. The high-latitude zone of the precipitation region has an average electron energy lower than 500 eV with heavy structures. The average energy flux of the low-latitude part are generally greater than 500 eV with smoother spatial structures. The boundary between the hard and soft regions is called the transition boundary. It is found that during quiet times the average location of the electron precipitation poleward about 63° to 64° in the morning, noon and evening sectors and at about 60° in the midnight sector. The equatorward edge is at about 70° in the morning, noon and evening sectors and at about 60° in the midnight sector. The latitudinal width of the region of auroral electron precipitation is unusually large, indicating a widening of the auroral oval in periods of geomagnetic quiescence. DMSP auroral imaging data further reveal that there are no bright, discrete optical auroras in the region of low-average-energy electron precipitation. Faint, stable auroral arcs sometimes are seen in the equatorial region of the high-average energy electron precipitation. The location of the poleward boundary is affected by the magnitude of the northward interplanetary magnetic field (IMF) component; however, the location of the precipitation equatorward boundary and of the transition boundary are not related to the positive IMF B_y magnitude. These results indicate that the unusually high latitude of the precipitation poleward boundary is the consequence of a very small number of geomagnetic flux tubes interconnected with the IMF during a northward IMF condition. They also imply that the size of the polar cap is inversely controlled by the magnitude of the northward B_z component. The insensitivity of the transition and plasmaward precipitation boundaries to the northward IMF B_y can be used to infer that the dynamics are dominated by internal magnetospheric processes and not by direct solar-wind–magnetosphere interactions.
J. Geophys. Res., A, Paper 4A0059

5560 Particles and Fields—Ionosphere (Particle Precipitation)
VELOCITY SHEAR STABILIZATION OF THE CURRENT CONVECTIVE INSTABILITY
P. Satyanarayana, S.L. Ossakow, (Naval Research Laboratory, Washington, D.C.)

A nonlocal theory of the current convective instability in the presence of a transverse velocity shear is developed. It is found that the velocity shear stabilizes the short wavelength modes and preferentially excites a long wavelength mode. Application to equatorial enhancements is discussed. (shear, currents, F layer high latitude)
J. Geophys. Res., A, Paper 4A0032

5563 Plasma motion, convection, or circulation
THE EFFECTS OF INTERPLANETARY MAGNETIC FIELD ORIENTATION ON HAVING HIGH LATITUDE IONOSPHERIC CONVECTION
R. A. Heelis (Center for Space Sci., Univ. of Texas at Dallas, Richardson, TX 75083)

The Atmosphere Explorer-C data base of northern hemisphere ionospheric convection signatures at high latitudes is examined during times when the interplanetary magnetic field orientation is relatively stable. It is found that when the IMF had the expected garden hose orientation, the center of a region where the ion flow rotates from zonward to antisunward is displaced from local noon to dawn irrespective of the sign of B_y. Poleward of this rotation region, called the cleft, the ion convection is directed toward dawn or dusk depending on whether B_y is positive or negative, respectively. The observed flow geometry can be explained in terms of a magnetosphere solar wind interaction in which merging is favored in either the pre-noon northern hemisphere or the pre-noon southern hemisphere when the IMF has a normal sector structure that is toward or away, respectively.
J. Geophys. Res., A, Paper 4A0064

5575 Plasma: Instabilities
THE WAVE NORMALS OF MAGNETOSPHERIC CHORUS EMISSIONS OBSERVED ON ISEE-1
H. Oya, (Tohoku University, Sendai, Japan), K. Morioka, (Tohoku University, Sendai, Japan), T. Tamanaka, (Tohoku University, Sendai, Japan), M. Kumamoto, (Tohoku University, Sendai, Japan), T. Obara, (Tohoku University, Sendai, Japan), M. Ejiri, (National Institute of Atmospheric Research, Tokyo, Japan), and T. Taguchi, (Tohoku University, Sendai, Japan)

The wave normal directions of magnetospheric chorus emissions have been analyzed by using data from the geostationary ORBS-2 satellite which is located in the equatorial region at L=6.6. As the result of analyses for a specific day of 19th December, 1979, chorus is found to be generated in conjunction with substorms and at local times from around midnight to afternoon. Two types of chorus are observed; impulsive burst-like and rising tone. The chorus during midnight to late morning hours is impulsive, and at local times from noon to dusk, we notice an increase in the occurrence of rising tone chorus. The chorus spectra have shown the importance of the characteristic frequency of $f_{H}/2$ (f_H: electron gyrofrequency). We notice the emissions only in the lower band ($f \leq f_H/2$, f:emission frequency) at local times from ~3h to noon, and then at L=6.6 with the predominant emission frequency lies in the upper band ($f > f_H/2$) with infrequent occurrence in the lower band, and there is obviously no correlation between the elements in both bands. However, there are several intense tones which seem to be correlated in both bands for strong two-banded impulsive chorus emissions observed only at L=6.6h. This correlation might be related with a resonant interaction between $f_H/2$ and $f_H/2$ caused by Landau damping as previously suggested.

The wave normals are determined by using only the magnetic field data. The direction finding analyses have been made for impulsive and rising tone chorus, separately, which have yielded different results. The lower band is first discussed. The wave normals of the rising tones with having the df/dt's as normally observed are found to have very small angles (5°–20°), then it is found that the rising tones with large df/dt's have shown larger wave normal angles of 30°–45°. These relatively large wave normal angles for the lower band gives further support to the loss-cone instability as the generation mechanism. While, the impulsive chorus is found to take relatively large wave normal angles (about 5°) then most rising tones. Further, it may be suggested that different types of chorus are associated with different wave normals. Next we are concerned with the upper band chorus whose generation mechanism is not well agreed upon. It is shown that the impulsive chorus in the upper band is generated with its wave normal close to the oblique resonance cone. This suggests that the upper band chorus is quasi-electrostatic, and it is furthermore confirmed by the estimated value of ω_{pe}/Ω_e (1st and 1st) (ω_{pe}: the total electric and magnetic field intensities, ω_e:the light velocity). While, the rising tones in the upper band have indicated a difference such that the closeness of their wave normals to the oblique resonance cone is much less distinct. An interesting comparison is made between the direction finding results for the upper band and the theoretical methodologies so far developed in order to elucidate the possible generation mechanism of the upper band chorus.
(Magnetosphere, VLF emissions, chorus, direction finding).
J. Geophys. Res., A, Paper 4A0058

5580 Wave propagation
PROPAGATION OF PLASMA WAVE ENERGY IN THE AURORAL E-REGION
D. R. Moorcroft (Centre for Radio Science and Department of Physics, University of Western Ontario, London, Ontario, Canada N6A 3K7)

The propagation of electrostatic plasma waves energy in the auroral E-region has been studied using field tracing. Typically a wave travels at high speed nearly parallel to the magnetic field, except possibly for a small height interval where it is reflected upwards throughout, in the direction of the propagation vector remains virtually unchanged, and nearly perpendicular to the magnetic field. If it makes an angle of more than 5.39° with the magnetic field the wave passes through the E-region without reflection. Irregularities in the magnetic field lines (due to auroral currents) may lead to trapping of waves in future less than this. Secondary irregularities may be localized in both horizontal and vertical extent because of their motion relative to the primary wave on which they depend for growth. The processes determining the amplitude of irregularities have also been considered in the light of this work. Several observed features of radio aurora may have explanations in terms of these properties of energy propagation.
J. Geophys. Res., A, Paper 4A0015

News

Geophysics and Overall Science Strong in FY 1985 Budget

A Mars mission, a new research thrust on the continental lithosphere, increased efforts in digital cartography, and construction of a Very Long Baseline Array radio telescope top the list of highlights for geophysics-related research in the proposed fiscal 1985 federal budget that President Ronald Reagan sent to Congress earlier this month.

Science in general fared well in this fourth Reagan budget. Research and development support would grow 14% to $53 billion ($5 1.8 billion would go to conduct of R&D, while $1.3 billion would be allocated to R&D facilities). With a projected inflation rate of about 4%, this increase would provide real growth of 10% over fiscal 1984 levels. The largest increase for R&D, 22%, would support defense modernization. Figure 1 compares nondefense federal R&D obligations since 1978 in constant 1983 dollars, while Table 1 compares conduct of R&D by major departments and agencies.

Basic research would get the next largest hike, up 10% to $7.9 billion, or about 6% growth above projected inflation. Agencies primarily supporting basic research in physical sciences and engineering are slated for better than a 14% boost, while those primarily supporting life and other sciences would get a 5.2% increase. Figure 2 compares basic research obligations in constant 1983 dollars for the five agencies with the largest basic R&D budgets.

Of the four nondefense agencies most involved in geophysical research, the National Science Foundation fared best with a 12.4% hike; the National Aeronautics and Space Administration is slated for almost a 4% increase. The U.S. Geological Survey took a slight dip (down 3.8%) in the budget request, but the National Oceanic and Atmospheric Administration's support would shrink 9.5%.

Congress, with an eye on the calendar and the November elections, has already begun work on the budget (see the list of budget hearings in this issue). *Eos* will track the budget as it moves through Congress.

Note: Increases and decreases listed in the following analysis compare the differences between fiscal 1984 and fiscal 1985, and do not reflect natural changes in the funding profile when a program phases in, matures and peaks, and then phases out. Numbers may not total because of rounding.

NSF Budget Up 12.4%

The budget request for the National Science Foundation is $1,501.79 million:

- $1,308.2 million for research and related activities
- $115.08 million for the U.S. Antarctic Program
- $75.7 million for science and engineering education
- $2.8 million for special foreign currency

Proposed are funds for

- construction of the Very Long Baseline Array (VLBA) radio telescope
- an expansion of efforts begun in fiscal 1984 to address researchers' needs for advanced computer systems
- initiation of centers for cross-disciplinary research in engineering

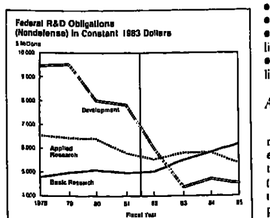
In addition, the budget request nearly doubles the money allocated for the Presidential Young Investigator Research Awards, which were initiated in fiscal 1984. In fiscal 1985, NSF plans to continue support for the 200 scientists selected this year and to support an additional 200. About half of the awards will be made to engineering faculty.

The following percentage increases and dollar requests are slated for the budgets of the various directorates that involve research and related activities:

- Engineering, 21.8% to $147.1 million
- Mathematical and Physical Sciences, 16.1% to $416.7 million
- Biological, Behavioral, and Social Sciences, 12.7% to $253.1 million
- Scientific, Technological, and International Affairs, 14.9% to $46.9 million
- Astronomical, Atmospheric, Earth, and Ocean Sciences (AAEO), 13.2% to $373.5 million.

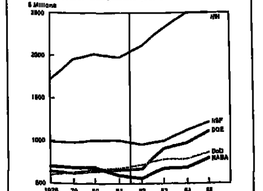
Within AAEO, the following percentage increases and dollar amounts are proposed.

- Astronomical Sciences, 19.5% to $93.4 million
- Earth Sciences, 17.1% to $48.6 million
- Ocean Sciences, 9.9% to $124.9 million
- Atmospheric Sciences, 10.3% to 98.6 million
- Arctic Research Program, 89% to $8.0 million.



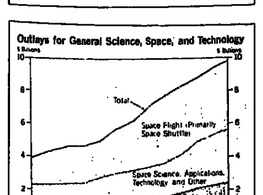
Source: Office of Science and Technology Policy.

Fig. 1. Nondefense federal R&D.



Source: Office of Science and Technology Policy.

Fig. 2. Basic research in five federal agencies.



Fiscal 1985," Office of Management and Budget.

Astronomical and Atmospheric Sciences

Slightly more than one-third of the $93.4 million proposed for the **astronomical sciences** division of AAEO is slated to support the National Radio Astronomy Observatory ($33.4 million, up 62.1%). Construction of the VLBA radio telescope will be the centerpiece of this program, as recommended by the National Research Council's Astronomy Survey Committee. Support for the Kitt Peak National Observatory, the Cerro Tololo Inter-American Observatory, and the National Solar Observatory totals $24.8 million (up 4.9%). The two other components of the astronomical sciences division are slated for smaller increases: astronomy project support is slated for $28.9 million (an increase of 4.3%), while the National Astronomy and Ionosphere Center would get $6.3 million (up 1.6%).

For astronomy project support, the biggest increases are proposed for extragalactic astronomy (up 28.5% to $7.5 million) and for galactic astronomy (up 17.6% to $5.3 million). Increases also proposed for fiscal 1985 are for solar system astronomy (up 1.6% to $1.3 million) and for stars and stellar evolution (up 3% to $6.5 million). Funds to support research on the electromagnetic spectrum management would remain the same as in fiscal 1984 ($100,000), while astronomical instrumentation and development would take a 15.2% cut to $8.2 million.

In the **atmospheric sciences** division, the largest increase is slated for the National Center for Atmospheric Research (NCAR) (up 14.8% to $45.9 million). Most of this increase results from the proposal for the installation of an advanced vector computer at the Boulder-based center. (Scientific computing would get a 42.2% boost to $13.4 million.) Other increases within NCAR would go to atmospheric analysis and prediction (up 4.5% to $3.6 million), to atmospheric chemistry and aeronomy (up 4.5% to $2.9 million), to convective storms (up 1% to $2.4 million), and to advanced study programs (up 4.5% to $1.5 million). Support for administration and support services is slated to increase 4.5% to $4.9 million and contractor fees are expected to rise 4.8% to $944,000. Physical plant operation and maintenance would get $5.3 million, a 42.3% hike. Slated for slight decreases at NCAR are funds for the High Altitude Observatory (down 2.1% to $3.5 million) and atmospheric technology (down 2.2% to $7.5 million).

Atmospheric sciences project support, the largest component of the atmospheric sciences division, would get $18.5 million, an increase of 6.6%. Proposed increases for individual projects hover around 8%; aeronomy is budgeted for $6.6 million, atmospheric chemistry for $7.5 million, climate dynamics for $7.8 million, experimental meteorology for $5.6 million, meteorology for $9.1 million, and solar-terrestrial research for $7.7 million. The Global Atmospheric Research Program (GARP) continues to phase down (a decrease of 6.3% to $4.5 million) with data analysis well underway.

The Upper Atmosphere Research Facilities program, the smallest component of the division, would get a 7.9% increase to $4.1 million.

Earth and Ocean Sciences

Most of the proposed increase for the **earth sciences** division goes to the continental lithosphere program. Recommended as a chief emphasis by the National Research Council's Board on Earth Sciences in their report, *Opportunities for Research in the Geological Sciences* and by the National Academy of Science's Research Briefing Panel on the Solid Earth Sciences (*Eos*, December 20, 1983, p. 985), this program would get $7.7 million in fiscal 1985, up from $3.7 million in fiscal 1984.

After the continental lithosphere program, the largest increase goes to instrumentation and facilities (up 20% to $6 million).

All of the other programs within the division are also slated for increased funding in fiscal 1985: stratigraphy and paleontology, up 5.4% to $3.9 million; surficial processes, up 7.4% to $2.9 million; crustal structure and tectonics, up 5.3% to $4.6 million; petrogenesis and mineral resources, up 5.1% to $4.1 million; volcanology and mantle geochemistry, up 8.3% to $3.9 million; and experimental and theoretical geochemistry, up 7% to $6.1 million. The seismology program and the experimental and theoretical geophysics program each would rise 6.4% to $5.0 million.

In the **ocean sciences** division, funding for the Ocean Drilling Program is slated to increase 4.9% to $27.6 million. Although costs for the program are expected to rise from $29.5 million in fiscal 1984 to $37.6 million in fiscal 1985, the contribution from other nations is expected to jump from $1.2 million to $10 million. Drilling is expected to commence at the start of fiscal 1985 (*Eos*, January 31, 1984, p. 34). Ocean science research support, the second component of the ocean sciences division, would get an 11.5% hike to $80.9 million. This support funds research in physical oceanography ($17.2 million, up 11%), marine chemistry ($13.4 million, up 11.7%), submarine geology and geophysics ($16.1 million, up 11%), and biological oceanography ($14.2 million, up 12.7%). The third component of ocean sciences, called oceanographic facilities and support, is slated for an 11.1% increase to $36.4 million.

Polar Programs

AAEO's arctic research division would receive $8.0 million for fiscal 1985, an increase of more than 8% over the current fiscal year. Biological sciences research is slated for the largest dollar increase, up $229,000 to $2.3 million, followed closely in atmospheric sciences (up $120,000 to $1.1 million) and earth sciences (also up $120,000 to $1.2 million). Glaciology research has been slated for a 7.1% increase to $2.1 million, while the funding for oceanography research in the Arctic remains unchanged at $1.2 million.

Money requested for the **U.S. Antarctic Program**, which is a separate activity and not part of AAEO, totals $115.1 million, an increase of $12.6 million over fiscal 1984. Antarctic research (up 7.4% to $11.0 million) includes funding for atmospheric sciences ($2.2 million, up 4.8%), biological sciences ($2.5 million, down 3.9%), earth sciences ($1.8 million, up 5.9%), glaciology ($1.9 million, up 18.8%), oceanography ($1.9 million, up 19.2%), and information and advisory services ($700,000, up 7.7%). Operations support for the U.S. Antarctic Program will increase 12.9% to $104.1 million.

Engineering

Within the Directorate for Engineering, the Division of Civil and Environmental Engineering is slated to receive $39.8 million, a 17.7% boost. Within the division, requested is $4.6 million (up 17.9%) for geotechnical engineering, $4.7 million (up 34.3%) for structural mechanics, $4.8 million (up 23.0%) for hydraulics, hydrology, and water resources en-

News (cont. on p. 50)

TABLE 1. Research and Development by Major Departments and Agencies in Millions of Dollars

Department or agency	Obligations			Outlays		
	1983 Actual	1984 Estimate	1985 Estimate	1983 Actual	1984 Estimate	1985 Estimate
Defense-military functions	22,925	27,836	33,852	21,057	23,310	31,053
Energy	4,491	4,814	4,885	4,771	4,853	4,744
Health and Human Services	4,348	4,859	4,950	4,022	4,529	4,860
National Institutes of Health*	(3,788)	(4,240)	(4,342)	(3,538)	(3,968)	(4,267)
National Aeronautics and Space Administration	2,570	3,257	3,311	2,538	3,462	3,314
National Science Foundation	1,002	1,230	1,408	992	1,136	1,362
Agriculture	846	872	898	832	866	880
Transportation	360	519	498	280	145	181
Interior	327	357	272	324	349	276
Commerce	241	250	281	242	252	277
Environmental Protection Agency	177	225	264	245	298	297
Agency for International Development	164	223	198	154	174	208
Veterans Administration	207	191	168	220	211	167
Nuclear Regulatory Commission	338	303	310	309	309	416
All other**	38,431	45,279	51,776	36,560	42,686	48,712
Total						

Source: Office of Management and Budget. Numbers may not total because of rounding.
*Figures in parentheses are part of the corresponding amount for Health and Human Services.
**Includes the departments of Education, Justice, Labor, Housing and Urban Development, and Treasury, the Tennessee Valley Authority, the Smithsonian Institution, the U.S. Army Corps of Engineers, and the Federal Emergency Management Agency.

Forum

Two-Career Couples: Information Exchange

AGU's Education and Human Resources Committee sponsored a panel session on The Two-Career Couple at the 1983 AGU Fall Meeting (a report on the session will appear in a forthcoming issue of *Eos*). The response was overwhelming—more than 150 persons crowded into the room, many of them midcareer professionals. Clearly, we had touched a nerve. In discussion following the panel presentation, members of the audience repeatedly expressed a desire for models, guidelines, or policy statements that could be shown to an employer, especially with reference to flexible work time, slow career advancement, and promotion policy. People felt that alternatives are feasible, and that the present lack of policies is largely due to ignorance, by both employers and employees, of practical solutions. "Surely, with so many women entering the work force, *some* corporations or agencies *must* have developed guidelines!"

It would be inappropriate for AGU to propose any such guidelines. However, we can collect and publicize information that might be useful. Below is a short list of relevant publications, kindly provided by Jennie Farley of the School of Industrial and Labor Relations at Cornell. **Members who know of other publications or policy statements by employers are urged to share this information via the AGU Committee on Education and Human Resources.**

The Woman in Management: Career and Family Issues, Jennie Farley, ILR Press, Cornell University, Ithaca, N. Y., 112 pp., 1983, $8.95.

Career Outcomes in a Matched Sample of Men and Women Ph.D's: An Analytical Report, N. C. Ahern and J. L. Scott, National Academy Press, Washington, D. C., 1981.

Careers and Couples: An Academic Option, L. Hoffmann and G. DeSole (Eds.), Modern Language Association, New York, 1979.

Companion and Two-Career Couples: Directions for the Future, Catalyst Career and Family Center, New York, 1981.

Climbing the Academic Ladder: Doctoral Women Scientists in Academe, NRC Commission on Human Resources, National Academy of Sciences, Washington, D. C., 1979.

Constance Sancetta
Member, Ad Education and Human Resources Committee

News *(cont. from p. 49)*

gineering, $3.8 million (up 15.2%) for *environmental and water quality engineering*, $2.4 million (up 20%) for construction engineering and building research, and almost $20 million (up 13.1%) for earthquake hazard mitigation.

NASA: Mars and Space Station

Although the proposed fiscal 1985 budget for the National Aeronautics and Space Administration (NASA), totaling $7491.1 million, shows just under a 4% increase over fiscal 1984, the budget includes three major new initiatives. Most hardly touted of these is a permanently manned space station, for *which $150 million* is requested (see story this issue).

Another initiative, a Mars mission called the Mars Geoscience/Climatology Orbiter (MGCO), would be "the first of a new series of relatively low-cost planetary observers designed to investigate specific questions in planetary science," according to NASA Administrator James M. Beggs. MGCO was part of the core program for planetary exploration recommended by the Solar System Exploration Committee of the NASA Advisory Council (*Eos*, May 24, 1983, p. 386, and February 15, 1983, p. 95). The funds requested in the fiscal 1985 budget ($46 million—within the planetary exploration category) would begin the design and development of the orbiter and its instruments, leading to a 1990 launch. MGCO will measure the geology and climatic evolution of Mars.

Development of the Upper Atmospheric Research Satellite (UARS) will begin in fiscal 1985. UARS will place into earth orbit instruments that will enable a comprehensive, global measurement of the stratosphere to be made.

Space Flight

Largest of the four NASA budget categories is Space Flight, Control and Data Communications, which, with proposed funding totaling $4000 million, represents almost half of the agency's budget. This category includes space shuttle production, operations, and tracking and data acquisition. Next largest research and development ($2300.1 million, followed by research and program management ($1431.0 million) and construction of facilities ($160.0 million).

Space Flight, Control and Data Communications is a new category representing an internal reorganization at the agency. Plans for fiscal 1985 include 11 space shuttle launches, the second and third spacelab missions, launch of the second and third Tracking and Data Relay Satellites (TDRSS), completion of the space shuttle fleet with the expected delivery of the fourth orbiter (Atlantis) in December 1984, and continued hardware development for the U.S.-Italian Tethered Satellite System. Specifically, funding for space shuttle production and operational capability drops 11.1% to $1075.0 million, while space transportation operations declines 7.8% to $1339.0 million. Support for space tracking and data acquisition grows 18.1% to $795.7 million. Despite the extensive plans, total funding for this category shows a 1.1% decrease from fiscal 1984, reflecting a maturation of the shuttle program.

Research and Development

Six activities fall under NASA's research and development category. (1) The largest is space science and applications, allocated with $1471.5 million, an increase of 20.9%. (2) The new space station would get $150 million in fiscal 1985, while 14 space transportation capabilities development is budgeted for $304.1 million, shrinking 16.4%. (4) Technology utilization would be funded at $9.5 million (up $500,000). (5) Aeronautics and space technology's $192.1 million (up $33.1 million or 12.1%), and (6) tracking and data acquisition $15.4 million (up by $1.1 million).

Physics and Astronomy

The space science and applications activity, in turn, is divided into four programs. The first, physics and astronomy, is budgeted for $677.2 million, an increase of 19.3% over fiscal 1984. The largest increases within this program would go to mission operations and data analysis (up 60.2% to $109.1 million), to Gamma Ray Observatory development (up 39.4% to $120.2 million), and to shuttle/spacelab payload development and mission management (up 90.3% to $105.4 million. Smaller increases are allocated to the suborbital program (up 12.2% to $58.7 million), to explorer development (up 6.6% to $51.9 million) and to research and analysis (up 3.1% to $30.9 million). Targeted for a slight decrease is space telescope development (down $4.0 million to $195.0 million).

Planetary Exploration

Planetary exploration, the second program within space science and applications, is budgeted for a 32% increase to $286.9 million. Most of the increase is attributable to the addition of $63.5 million (up 219%) to support the Venus Radar Mapper mission, bringing the total for fiscal 1985 to $92.5 million. The newly proposed Mars Geoscience/Climatology Orbiter is budgeted for $46.0 million. Hefty increases also are slated for the International Solar Polar Mission (up 50% to $9 million) and to mission operations and data analysis (up 35.5% to $58.8 million). Because much of the foundation work is completed for the development of Galileo, a decrease of 29.4% to $56.1 million is proposed. Research and analysis is slated for an 8.4% cut to $34.5 million.

Space Applications

Space applications, the third component of the space science and applications subactivity, would get an overall 18.2% boost to $344.1 million. This program is divided into solid earth observations (down 15.6% to $63.6 million), environmental observations (up 36.2% to $220.7 million), materials processing in space (down 2.3% to $23.0 million), communications (down 2.4% to $20.6 million), and information systems (up 82% to $16.2 million).

Within **solid earth observations**, funding for the shuttle/spacelab payloads would grow 13.1% to $18.1 million, while geodynamics and research analysis would each increase 6.8% to $29.9 million and $15.6 million, respectively. There is no money in the NASA budget for Landsat-4 (which, as the in-orbit Landsat-D, is handled by the National Oceanic and Atmospheric Administration).

Within **environmental observations**, support for the upper atmosphere research satellite mission would more than triple to $60.7 million. Extended mission operations is budgeted for $29.5 million (up 7.7%), upper atmosphere research and analysis would get $31.0 million (up 8.8%), atmospheric dynamics and radiation research and analysis would get $28.5 million (up 3.6%), oceanic processes research and analysis would get $19.4 million (up 6.6%), and space physics research and analysis would receive $16.7 million (unchanged from fiscal 1984). Funding for the shuttle/spacelab payload development would grow 2.6% to $7.8 million. Additions to the program include the scatterometer ($15 million), the tethered satellite payload ($3.0 million), and *interdisciplinary research* and analysis ($1 million). Funding for the earth radiation budget experiment (ERBE) nearly halves to $8.1 million. The operational satellite improvement program is eliminated in the fiscal 1985 budget request.

The **life sciences** program, the fourth component of the space science and applications activity, is budgeted for a 9.1% increase to $63.5 million.

USGS Underscores Mapping

Funding for the U.S. Geological Survey (USGS) proposed for fiscal 1985 totals $391.8 million (a decrease of 3.8% from fiscal 1984) (see Table 2 for a *breakdown of major categories*). Digital cartography, part of the national mapping program, has been allocated a $3.3 million increase. The additional funds will initiate digitizing of hydrography and transportation data for the counties at a scale of 1:100,000. This will aid the Bureau of Census prepare for the 1990 census.

Geologic and Mineral Resources

Within the **geologic hazards** subactivity within Geologic and Mineral Resources, none of the programs are budgeted increases. The earthquake hazards reduction program would receive $33.1 million (down 6.2%), resulting in a 10% reduction in earthquake monitoring networks and approximately a 15% reduction in quake prediction networks. Ten projects in earthquake prediction studies and five field projects on earthquake potential in California would be discontinued. The volcanic hazards program would get $9.5 million (down 12.8%), and the ground failure and construction hazards program would get $2.1 million (same as fiscal 1984).

The **land resource surveys** subactivity, with a total proposed budget of $20.0 million for fiscal 1985, includes the geomagnetism program (down 9.1% to $2 million), the climate changes program (halved to $0.5 million), and the geologic framework program (up 24.1% to $17.5 million). These cuts would mean delaying final magnetic chart production for about 1 year, eliminating two research projects to develop new mathematical models, and terminating investigations assessing the link between climate change and variations in the earth's magnetic field. The geologic framework program incorporates the reactor hazards program that had previously been included in the geologic hazards subactivity and includes a $1 million initiative for cooperative federal/state geologic and geophysical mapping.

The **mineral resource surveys** *subactivity* shows a $1.4 million increase to $46.3 million. Slated for the largest percentage increase is development of assessment techniques, up 4.1% to $12.8 million. Also allocated funding growth are the Alaska program (up 1.1% to $9.5 million), the coterminous states program (up 3.3% to $5.9 million), the wilderness program (up 2.4% to $8.5 million), and the strategic and critical minerals program (up 3.3% to $9.5 million). Increases for the coterminous states and the critical minerals programs were for pay cost increases.

Energy geologic surveys would show a net decline of 13.6% to $26.0 million. Some of the money from the coal investigations program and the *onshore oil and gas investigations* program has been moved into a new program called "evolution of sedimentary basins," which has been budgeted for $4.7 million in the fiscal 1985 budget request. Coal investigations would get $7.4 million and onshore oil and gas investigations would receive $4.7 million. Oil shale investigations would grow 20% to $600,000. Decreases are proposed for uranium/thorium investigations (down 19.3% to $3.3 million) and for the geothermal program (down 25% to $5.4 million), suspending studies of shallower, high-temperature hydrothermal resources. The would energy program has been eliminated.

The fifth subactivity, **offshore geologic surveys**, would get a 2.7% increase to $19.1 million. A significant part of the work would focus on assessing the mineral and energy resources in the 200-mile Exclusive Economic Zone.

Water Resources

Within the **National Water Data System: Federal Program** subactivity, a $900,000 increase has been allocated to the data collection and analysis program, bringing its budget up to $16.9 million in the next fiscal year.

Other increases within the subactivity have been apportioned to the improved instrumentation program (up 5% to $2.1 million), the water resources assessment program (up 7.7% to $1.4 million), the toxic substances program (formerly called the toxic waste-groundwater contamination program) (up 4.7% to $8.9 million), the acid rain program (up 6.7% to $3.2 million), the environmental affairs program (up 14.3% to $800,000), and the coordination of national water data activities program (up 11.1% to $1.0 million to cover pay cost increases).

Decreases in the subactivity are slated for the national water data exchange program (down 23.1% to $1.0 million) (resulting in a 10% reduction in capability to respond to inquiries), the regional aquifer systems analysis program (down 3.3% to $14.6 million), the core program of hydrology research (an 8.5% drop to $6.5 million), and supporting services (a two-thirds cut to $1.1 million). The budget this year keeps the water resources scientific information center at $900,000 and again allocates money to the flood hazard analysis program.

Within the **National Water Data System: Federal/State Cooperative Program**, the data collection and analysis program would get a 1.7% boost to $42.7 million to cover pay cost increases, while funding for the water use program would drop by nearly 25% to $3.0 million. The coal hydrology program has been allocated $4.4 million, a 37.5% increase.

In the **energy hydrology** subactivity, the nuclear energy hydrology program would receive $7.6 million (up 5.6%) and the oil shale hydrology program would receive the same funding as in fiscal 1984, $300,000. The coal hydrology program that had been contained in this subactivity has been consolidated with the coal hydrology program in the federal/state cooperative program.

The **Water Resources Research Institute** has been eliminated from the Water Resources Investigations activity.

TABLE 2. USGS Budget, in Millions of Dollars

Activity	FY 1983	FY 1984	FY 1985 Proposal	Change, 1984 to 1985, in Percent
Geologic and Mineral Resource Surveys				
Geologic hazards	51.6	51.4	44.8	−12.8
Land resource surveys	17.5	17.2	20.0	+16.3
Mineral resource surveys	41.1	44.9	46.3	+3.1
Energy geologic surveys	31.2	30.1	26.0	−13.6
Offshore geologic surveys	15.5	18.6	19.1	+2.7
Subtotal	159.8	162.2	156.2	−3.7
Water Resources Investigations				
National water data system: federal program	55.1	60.3	58.5	−3.0
National water data system: federal/state cooperative program	45.8	49.1	50.1	+2.0
Energy hydrology	15.1	11.9	7.9	−33.6
Water Resources Research Institute	0	6.4	0	−100.0
Subtotal	116.0	127.6	116.5	−8.7
National Mapping Program	90.7	90.1	90.4*	+0.3
Facilities	9.0	10.4	13.3	+27.9
General administration	14.9	15.5	15.4	−0.6
Total, USGS	390.5	405.9	391.8	−3.8

Source: USGS. Numbers may not total because of rounding.
*Includes $11.3 million for digital cartography, up 41.8% from FY 1984 and up 1829% from FY 1983.

NOAA Budget Declines

The total budget appropriation request for the National Oceanic and Atmospheric Administration (NOAA) is $899.3 million, a decrease of $94.2 million from the fiscal 1984 appropriation of $993.5 million. The budget includes proposals for users of NOAA's services to pick up a greater share of the costs, for the continued funding of the Next Generation Weather Radar (NEXRAD) and the modernization of the National Weather Service, and for the procurement and operation of two geostationary and one polar-orbiting meteorological satellites. The budget request consists of a program requirement of $1,017.8 million, which would be offset by various transfers, adjustments, and revenues from service charges that total $118.5 million.

The lion's share of NOAA's funding would go to Operations, Research, and Facilities (ORF), targeted to receive $921.5 million, $93.3 million less than appropriated for fiscal 1984. Many of the cuts proposed for ORF had been requested for fiscal 1984, but were subsequently restored by Congress. ORF is divided into five activities: ocean and coastal programs, marine fishery resource programs, atmospheric programs, satellite and environmental data and information services, and program support.

Atmospheres and Satellites

Atmospheric Programs

Better than one-third of ORF's funds would go to the atmospheric programs activity. The budget request of $358.2 million (down 2.1% from fiscal 1984) is split between public warning and forecasting services ($311.0 million, virtually unchanged from FY 1984) and atmospheric and hydrologic research ($47.2 million, down $6.1 million). Among the proposals included in the decreases for public warning and forecasting services are closing the southern region headquarters, eliminating regional hydrologists offices, reducing staff at eight weather service forecast offices, and reducing night staffs at those offices. The decreases slated for atmospheric and hydrologic research include reducing funding to the Prototype Regional Observations and Forecast Service (PROFS) (*Eos*, April 13, 1982, p. 233), to National Weather Service research and development, *to acid rain research, and the elimination of* research and some services at the Solar Environmental Laboratory.

Satellites and Environmental Data and Information Services

The second largest of ORF's five activities, Satellite and Environmental Data and Information Services, is budgeted for $271.7 million in fiscal 1985, an increase of $22.3 million. The largest *boost—25%—within this activity* would go to the **satellite services** subactivity. The $84.9 million allocated would allow NOAA to assume responsibility for the Gilmore Creek, Alaska, data acquisition now operated by NASA, and would fund operation processing of solar backscatter ultraviolet data and for correction of system deficiencies in the polar ground system. In addition, the geostationary satellite's temperature and moisture sounding capability would be converted from a research prototype to an operation system by upgrading the ground system.

Satellite systems, the largest subactivity, is slated for a 4.1% hike to $164.2 million, which would allow the procurement of a spacecraft and associated launch services to continue to convert to a one polar satellite system. Funding for the last subactivity, data and information services, would show a 14% drop to $22.6 million.

Ocean and Coastal Programs

Next largest of ORF's activities, called ocean and coastal programs, allocated $106.1 million (a drop of better than 25%), is itself divided into six categories: nonliving marine resources (cut by nearly two-thirds to $1.3 million), ocean research (cut by one-third to $18.0 million), ocean services (down 29.6% to $19.1 million), Sea Grant (once again proposed for elimination), mapping, charting, and geodesy programs (slated to increase by 25% to $62.2 million), and coastal zone management, which in the past Congress has budgeted separately (slated to receive $5.6 million).

Within **nonliving marine resources**, the budget request proposes to eliminate the polymetallic sulfide program and the ocean thermal energy conversion program. Cuts to *the ocean research subactivity include* terminating the Undersea Research Program and shrinking the CANSP/TOGA project. Also proposed is the closing of the Great Lakes Environmental Research Laboratory (GLERL; the fiscal 1984 budget request also proposed to close the laboratory (*Eos*, May 17, 1983, p. 578), but Congress restored it.

Increases for the **ocean services** subactivity are proposed to cover the cost of producing tide and current publications; receipts from charges for this service will be deposited in the federal treasury. Decreases are proposed for, among others, the circulators program, the marine boundary survey program, the Chesapeake Bay study, and the bathymetric swath survey system project. The fiscal 1985 budget proposes to terminate the Sea Grant Program; Congress has restored the program every year.

Although the program level will remain the same for the **mapping, charting, and geodesy** subactivity, decreases are proposed in aeronautical chart services and nautical chart services. Direct funding of technical support to state geodesy programs would be reduced and a state-specific geodetic survey program would be eliminated. The president's budget requests that nautical and aeronautical chart prices be increased to more accurately reflect their full market value.

Coastal zone management (CZM) has been included in ocean and coastal programs with *a proposal to phase out the CZM state grants* program, to eliminate the states' assistance program, and to reduce the estuarine sanctuary program.

Marine Fishery & Program Support

The **marine fishery resource** programs, the fourth activity within ORF, is budgeted for a 35.7% cut to $92.6 million. This includes $59.1 million (down $12.7 million for) information collection and analysis, $29.1 million (down $24.1 million) for conservation and management operations, and $4.1 million (down $17.2 million) for state and industry programs.

ORF's last activity, **program support**, has *been allocated $92.8 million, a cut of 17.2%* from fiscal 1984. Proposed decreases include eliminating the National Advisory Committee on Oceans and Atmosphere (NACOA), reducing general administration, deactivating the fisheries research fleet, reducing days at sea, laying up of the *Auriga* and the *Ferrel*, reducing maintenance on both those ships and on *Freeman*, and closing the southeast marine support facility.—*BJR*

Budget Hearings

The tentative schedule for congressional hearings on the Reagan budget request for fiscal 1985 is listed below. Dates and times should be verified with the committee or subcommittee holding the hearing; all offices on Capitol Hill may be reached by telephoning 202-224-3121.

February 22: National Science Foundation (NSF), by the Science, Technology, and Space Subcommittee of the Senate Commerce, Science, and Transportation Committee. Senate Russell Office Building, Room SR-253, 9:30 A.M.

February 22: National Aeronautics and Space Administration (NASA) (space transportation systems), by the Space Science and Applications Subcommittee of the House Science and Technology Committee. Rayburn House Office Building, Room 2325, 1 P.M.

February 23: U.S. Geological Survey, by the Interior and Related Agencies Subcommittee of the House Appropriations Committee. Rayburn House Office Building, Room B308, 10 A.M.

February 23: NSF, by the Science, Technology, and Space Subcommittee of the Senate Commerce, Science, and Transportation Committee. Senate Russell Office Building, Room SR-253, 9 A.M.

February 28: NASA, by the Science, Technology, and Space Subcommittee of the Senate Commerce, Science, and Transportation Committee. Senate Russell Office Building, Room SR-253, 9:30 A.M.

February 28: NSF, by the Science Research and Technology Subcommittee of the House Science and Technology Committee. Rayburn House Office Building, Room 2318, 2 P.M.

February 29: NASA (space tracking and data systems and technology utilization), by the Space Science and Applications Subcommittee of the House Science and Technology Subcommittee. Rayburn House Office Building, Room 2325, 1 P.M.

February 29: NSF by the Science Research and Technology Subcommittee of the House Science and Technology Committee. Rayburn House Office Building, Room 2325, 9:30 A.M.

March 1: NASA, by the Science, Technology, and Space Subcommittee of the Senate Commerce, Science, and Transportation Committee. Senate Russell Office Building, Room SR-253, 9 A.M.

March 1: NASA (construction of facilities and research and program management), by the Space Science and Applications Subcommittee of the House Science and Technology Committee. Rayburn House Office Building, Room 2325, 10 A.M.

March 8: NASA, by the Science, Technology, and Space Subcommittee of the Senate Commerce, Science, and Transportation Committee. Senate Russell Office Building, Room SR-253, 9 A.M.

March 13: Markup of the authorization for the **NASA** budget by the Space Science and Applications Subcommittee of the House Science and Technology Committee. Rayburn House Office Building, Room 2325, 9:30 A.M.

March 29: NASA, by the HUD-Independent Agencies Subcommittee of the Senate Appropriations Committee. Senate Dirksen Building, Room SD-124, 10 A.M.—*BJR*

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Cover. Water flow paths in geothermal energy reservoirs are often dominated by fractures, whether natural or hydraulically induced, as is the case in the Los Alamos Hot Dry Rock project. The extracted water must be disposed of after its energy is removed for beneficial purposes, and often the best recourse is to reinject the cooled water back into the same fractures from which it was extracted. In that case the objective is to avoid too early an arrival of the cold recharge at the extraction well and at the same time avoid the expense of piping the recharge great distances away. An attractive alternative in the case of vertical or steeply dipping fractures is to attain adequate separation by using gravity and the density difference between the cold recharge and hot effluent. For a given geometry the effectiveness of gravity separation improves as the *ratio* of the Grashof and Reynolds numbers increases: Increasing the water density difference or the fracture permeability enhances separation, but increasing the recharge rate diminishes it.

The apparatus in the photos represents a vertical fracture viewed from the side. The upper clear plastic tube provides the hot water outlet; the tube below is used for recharge; and the recirculated water is cooled in a peripheral heat exchanger, not shown. The water is confined between a transparent, Plexiglas sheet (in front) and an electrically-heated back surface. The metal framework attached to the Plexiglas sheet allows accurate and uniform setting of the distance between the confining surfaces, thus controlling the fracture permeability.

Streamlines are observed through the use of two methods. In the first method, using the technique of D. J. Baker (*Journal of Fluid Mechanics*, 26, 573–575, 1966), fine platinum wires were immersed in the water (which is actually a dilute solution of thymol blue (thymolsulphonephthalein) titrated to the end point). When the wires are electrically charged, the current flow and resulting *pH* change cause the solution passing over the wires to turn blue. Continued application of voltage on many such wires distributed throughout the fracture reveals the steady state streamline patterns. In the second method, a previously prepared volume of blue solution is injected into the recharge just before entry into the fracture. One then observes the time-development of the fluid motion; this method is analogous to the tracer technique used in actual reservoirs.

In (*a*) the density difference is zero and the tightly bunched streamline pattern revealed by the charged-wire technique illustrates flow "short circuiting," which results in rapid reduction of effluent temperature. At a moderate Grashof/*Reynolds* number ratio, 2, the tracer technique reveals the flow pattern in (*b*), in which a substantial fraction of the recharge first flows downward, thus delaying thermal degradation of the effluent. For a very large Grashof/Reynolds number ratio, 40, the patterns in (*c*) and (*d*) result. Using the tracer technique, (*c*) shows the formation of a descending jet. The charged wires depict, in (*d*), the water motion after the jet encounters the fracture bottom, turns, and then flows to the extraction tube; thermal degradation is delayed for the maximum possible duration. The oscillatory appearance of the descending jet in (*c*) is due to the Kelvin-Helmholtz shear instability. Another, more familiar example is the formation of water waves from the wind. (Photos courtesy of investigators Hugh Murphy, Scott Faas (now at Sandia National Laboratories, Livermore, Calif.), and Paul Nabholtz (now at SEDCO, Inc., Dallas, Tex.), Los Alamos National Laboratory, Los Alamos, NM 87545.)

Gravity Theory Test Planned

The National Aeronautics and Space Administration (NASA) has decided to proceed with one of the most sophisticated attempts yet to test Einstein's gravitational theory. The proposed Gravity Probe B mission-unmanned spacecraft program has been included in the agency's fiscal Year 1985 budget request but only after considerable in-depth evaluation, both scientific and financial. Budgeted at $1.8 million for study in fiscal year 1984, it has been proposed at $3–5 million in fiscal year 1985 under the Physics and Astronomy Research and Analysis section of NASA's budget.

The idea of Gravity Probe B is to test the general theory of relativity by examining in fine detail changes of the precision parameters of an earth-orbiting gyroscope (*Science*, 223, 30, 1984). The gyroscope will be a cryogenically cooled, highly sensitive instrument specifically designed for the measurements. The engineering concepts have been under development for decades, and although the effects being sought are subtle, the experiment is considered to be within the realm of feasibility.

As with almost all experiments designed to test general relativity theory, Gravity Probe B has the appeal of making a substantial contribution to basic physics as well as to astrophysics and geophysics. At the same time, such a contribution carries the stigma of being basic and difficult to obtain and thus a bit far out of the main stream of space science projects.

NASA let the scientific community decide on this project in the sense that a great demonstration of support from a broad sector of scientists could be justification for new funding. Otherwise, Gravity Probe B would have to compete with other planned projects for a place in the existing budget request. "Deputy administrator Hans Mark has simply threatened to delete it from the agency's budget. It is an unusual technique to say the least, but effective: the space science community is obliging him with protests, letters, and outraged statements of support for the mission," according in *Science*.

This "outrage" resulted in strong endorsement by the Space Science Board and from many powerful supporters within the scientific community. Assuming the the budgets are approved, Gravity Probe B will fly in the early 1990's.—*PAIB*

Active Faulting Near Taupo

The only confirmed fault displacement in New Zealand since that accompanying the 1968 Inangahua Earthquake was observed on June 23 and 24, 1983, 4 km west of Taupo in the Taupo Volcanic Zone, central North Island (Figure 1). Normal displacement occurred on the late Quaternary Kaiapo fault, previously active in 1922, when almost 1 m of normal fault displacement was observed (*Lounge*, 1932). The Kaiapo fault is one of a number of north-east to ending normal faults that constitute the active Taupo Fault Belt (*Lensdale*, 1984). Current extension rates up to 7 mm per year have been calculated from geodetic observations (*Stevens*, 1979) across the northern part of the Taupo Volcanic Zone.

Maximum displacement of 2 km north of Lake Taupo was 50 mm upthrow to the southeast with 30 mm extension across the steeply dipping normal fault. No strike-slip displacement was observed. Total length of the observed 1983 surface trace is 12.00 m, comprising a set of tensional cracks up to 10 m in length, locally left stepping en echelon in nature (Figure 2).

Following several Modified Mercalli (MM) 4–5 intensity earthquakes reported on June 20 and 21, 1983, a local resident noticed a number of cracks near the base of the fault scarp on his property south of Mapara Road. Following more MM 3 and 4 earthquakes on the night of June 23, the cracks propagated to the northeast and on the morning of June 24, a scientific inspection team observed displacement of the surface of Mapara Road.

These earthquakes were part of a local swarm that had commenced on June 16. Earthquake magnitudes were up to 3.9 with a maximum of 20 teh events per day. Earthquake activity in the area of the fault displacement died away by June 29, migrating first to the north then to the south below Lake Taupo. Active fault displacement appears to have ceased following June 23, although seismicity and minor ground deformation continued.

The surface displacement occurred within the Kaiapo tilt-leveling pattern, one of 12 such arrays regularly monitored by New Zealand Geological Survey around Lake Taupo; 47 mm of displacement was measured on one of the 600-m long precise-leveling radials in agreement with the observed surface displacement. In addition, regular measurements of Lake Taupo water level taken as part of a regional vertical deformation monitoring program recorded relative uplift in the epicentral area for at least 3 months prior to the swarm. Rapid subsidence totaling 50 mm and displacement at the Kaiapo Fault were associated with the earthquake swarm (Figure 3).

Prior to the Kaiapo faulting, during an earthquake swarm on the western margin of the Taupo Volcanic Zone in February-March 1983, a seismographic network was established for one week west of Kinloch (Figure 1). Associated regional uplift (Figure 3) led to additional lake leveling stations being installed.

After the Kaiapo faulting, seismographs were again deployed around the northern shores of Lake Taupo from June 29, 1983, until July 4, 1983, recording events largely to the south of the surface fault displacement, that of magnitude 4.3 on July 1 being the largest event recorded. A composite focal

News *(cont. on p. 52)*

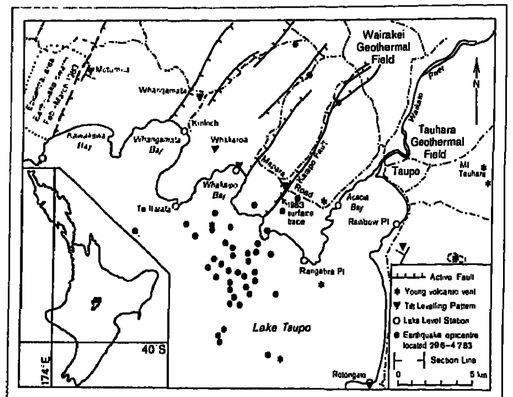

Fig. 1. Northern Lake Taupo region showing epicenters of early July 1983 earthquakes in relation to active faulting and young volcanic centers. Location of Kaiapo fault break shown

Fig. 2. Detail of surface trace with animal track displaced 50 mm down to the northeast and 20 mm extension. Hammer is 34 cm in length

mechanism gave a horizontal E-W tensional axis in agreement with regional extension. Epicentral positions, focal depth and mechanisms, and b values are all preliminary. The b value of 0.75 ± 0.11 is similar to that determined in the nearby Wairakei Geothermal field (*Hunt and Latter, 1982*) and to that determined in the early 1983 Kinloch swarm (T. H. Webb, personal communication, 1984).

Others of New Zealand Geological Survey and Seismological Observatory, Geophysics Division Department of Scientific and Industrial Research, are responsible for geodetic, geologic, lake level and seismicity observations both at the 1983 fault trace and elsewhere within the Lake Taupo Region. Precise leveling on some of a 50-km transect of the Taupo Fault Belt to the north is currently being repeated by the Department of Lands and Survey to look for undetected surface deformation. Detailed results are to be presented at the forthcoming Recent Crustal Movements Symposium to be held in Wellington, New Zealand this month.

Further information is available from A. G. Hull and G. W. Grindley, New Zealand Geological Survey, Box 30–368, Lower Hutt (geology); P. M. Otway, New Zealand Geological Survey, and T. M. Hunt, Geophysics Division, DSIR, Private Bag, Taupo (geodesy, lake leveling, seismicity); and from T. H. Webb, Seismological Laboratory, California Institute of Technology, Pasadena, CA 91109 (seismology).

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This news item was contributed by Alan G. Hull *and* George W. Grindley, *who are with the New Zealand Geological Survey, Lower Hutt, New Zealand.*

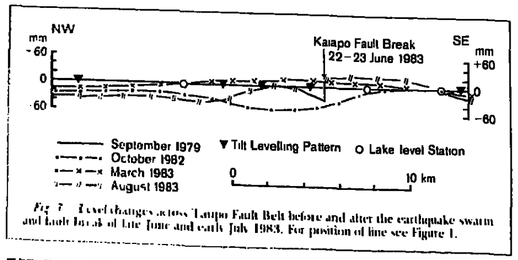

Fig. 3. Level changes across Taupo Fault Belt before and after the earthquake swarm and fault break of late June and early July 1983. For position of line see Figure 1.

VLBI Observatory Begins Operations

A new radio telescope observatory located at Richmond, Fla. (near Miami), made its first successful Very Long Baseline Interferometry (VLBI) observations on December 9, 1983, according to the National Geodetic Survey (NGS). That test session was followed on December 21 by the first operational observing session of the full, three-station POLARIS (Polar Motion Analysis by Radio Interferometric Surveying) network. The Richmond facility plus observatories near Boston, Mass., and El Paso, Texas.

The POLARIS network was joined in the historic December 21 observing session by VLBI observatories in Onsala, Sweden, and Wettzell, Federal Republic of Germany. Only 8 hours of operations yielded sufficient data to determine the location of the Richmond site relative to the other four North American and European observatories to within a fraction of a meter. Refinements will quickly reduce uncertainties to a few centimeters.

Regular, 24-hour observing sessions with the POLARIS network will allow geodesists to monitor the wobble of the earth on its axis—a phenomenon known as polar motion—and variations in the rate of rotation of the earth, i.e., the passage of Universal Time. The POLARIS stations will also be used in conjunction with mobile VLBI systems to study deformation of the North American tectonic plate, and with observations on different plates to study global plate motions.

The first successful observations from the Richmond POLARIS observatory culminated nearly 7 years of planning and building by NGS (a component of the National Oceanic and Atmospheric Administration), the U.S. Naval Observatory, and the National Aeronautics and Space Administration (NASA), aided by several other organizations. The 17-m-diameter radio telescope was donated by the Carnegie Institution of Washington.

All three POLARIS observatories are equipped with the state-of-the-art Mark III VLBI data acquisition system, developed by a team of scientists and engineers from the Massachusetts Institute of Technology, Haystack Observatory, the National Radio Astronomy Observatory, and Goddard Space Flight Center, under funding from NASA and the National Science Foundation. The Mark III VLBI system can record as many as 112 million bits of data per second. During a typical 24-hour observing session, each observatory records more than a trillion bits of data. The entire process of collecting and reducing the data relies heavily on computerized automation.

The first two POLARIS observatories have been operating for nearly 3 years. The POLARIS length-of-day series captured an extraordinary change in the rate of rotation of the earth during January and February 1983, coincident with the strongest episode of the El Niño ever recorded. Early success of project POLARIS has led scientists in several other nations to develop dedicated geodetic VLBI observatories. The first operating foreign observatory is located in the village of Wetzell in Bavaria, Federal Republic of Germany. Others are nearing completion in Japan and the People's Republic of China. Together with the POLARIS observatories, these stations will form a global geodetic VLBI network, known as the International Radio Interferometric Surveying (IRIS) system.

The IRIS stations are also supporting an even broader international effort, organized by the International Union of Geodesy and Geophysics and the International Astronomical Union, known as project MERIT (Monitor Earth Rotation and Intercompare the Techniques of observation and analysis). Project MERIT involves the application of several advanced technologies (including VLBI, satellite laser ranging, and lunar laser ranging) to the study of the dynamics of the earth.

This news note was contributed by William E. Carter, *who is with the National Geodetic Survey, Rockville, MD 20852.*

Molecular Computers

Computer circuits consisting of organic molecules could offer a solution to problems foreseen in future processor designs. Geophysicists and astronomers are among those needing huge, ultrafast computational facilities. It takes the ultimate in computing power to track fluid flow in petroleum reservoirs, to *analyze data* from 3-dimensional instrument arrays, and to conduct imaging measurements of planetary surfaces in real time.

In a sense, silicon and get-uantium integrated computer circuit designs are running out of the time-space dimensions to fill the need. Organic molecular circuits, some of which will contain no metallic conduction elements as normally conceived, may be able to be produced with appropriately small time delays and physical dimensions between electronic elements. Because of limitations of conventional integrated circuits, the number of transistors that can be fabricated onto a single chip may never exceed $0.6–1 \times 10^6$. This number may have no relevance to molecular computer circuits, in which logically based entities provide intelligent switches much like those of living systems.

A molecular computer is still a long way from being a reality, but interest in their potential is rising rapidly. In a recent workshop on chemical-based computers, sponsored by the National Science Foundation, new avenues for research were being considered. F. Eugene Yates, head of the Crump Medical Institute of the University of California, which cosponsored the conference, stated, "If we go to a molecular computer . . . we're talking about achieving spacing of elements 1/1,000th of that [attainable with silicon] . . . we could probably increase computational diversity between 1 and 10 million times what can be done at present" (*Research and Development*, January 1984).

A competitive molecular computer may not arrive until the next century; however, when it does appear its properties may be impressive. What is predicted is the application of current biological engineering, ranging from those related to recombinant DNA to protein and enzymes. The new biological computers could have "mood" changes to aid in parallel processing of signals. Molecular electronics in general is likely to exploit the full range of biochemical advances. The existing discovery of organic superconductors may find useful application in producing the first resistance-free conduction actually used in computers.—*PMH*

Cornell Continents Institute

Cornell University has formed a new research unit to study the origin and evolution of the continents. Initially, the new Institute for the Study of the Continents will comprise research efforts in geological sciences at Cornell now carried out under the Cornell Program for the Study of the Continents, the Consortium for Continental Reflection Profiling Project, the Andean Project, and related studies of crustal geology. The institute will be quartered with the Department of Geological Sciences in Snee Hall, an earth science facility now under construction. Jack Oliver, former chairman of the Department of Geological Sciences, has been appointed to a 5-year term as first director of the Institute.

This news item was contributed by Thomas Everhart, *who is with the College of Engineering, Cornell University, Ithaca, NY 14853 0125.*

Geophysicists

Peter S. Eagleson

Peter S. Eagleson, of the Massachusetts Institute of Technology civil engineering department, has been named Edmund K. Turner Professor of Civil Engineering. Currently president of the AGU Hydrology Section, Eagleson in 1979 received the section's Horton Award. Eagleson has been a member of the MIT faculty since 1955 and was chairman of the civil engineering department from 1970 to 1975.

Peter Brewer returned to the Woods Hole Oceanographic Institution after 2 years as the program director for the marine chemistry program in the National Science Foundation's Division of Ocean Sciences. ***Curtis A. Collins*** has returned to the division as program manager for ocean dynamics after spending 1 year at Woods Hole as a guest investigator in physical oceanography.

Tjeerd Van Andel, professor of oceanography at Stanford University, has been awarded the Van Waterschoot Van Der Gracht medal from the Royal Netherlands Geological Society for his lifetime contributions to the earth sciences.

John G. Weihaupt, formerly the dean of graduate studies and research at San Jose State University in San Jose, Calif., is the new vice chancellor for academic affairs at the University of Colorado in Denver.

Recent Ph.D.'s

Eos periodically lists information on recently accepted doctoral dissertations in the disciplines of geophysics. Faculty members are invited to submit the following information, on institution letterhead, above the signature of the faculty advisor or department chairman:

(1) the dissertation title,
(2) author's name,
(3) name of the degree-granting department and institution,
(4) faculty advisor,
(5) month and year degree was awarded.

If possible include the current address and telephone number of the degree recipient (this information will not be published).

Dissertations with order numbers, and many of the others listed, are available from University Microfilms International, Dissertation Copies, P.O. Box 1764, Ann Arbor, MI 48106.

Analysis of Solution and Gas Phase Molecular States of Formaldehyde by Gas Chromatography and Chemical Ionization Mass Spectrometry, David F. Utterback, Univ. of North Carolina, Chapel Hill, 1983 (GAX83–26261).

Application of Optimization Methods to the Inversion of Aeromagnetic Data (Brazil), Lourenildo W. B. Leite, Saint Louis Univ., 1983 (GAX83–25388).

Association of Cobalt, Nickel, Copper, and Zinc With Iron and Manganese Oxides of Soils, James A. Frampton, Univ. of California, Davis, 1983 (GAX83–26072).

Clastogenic Activity of Phenolic Oxidation Products, Ann F. Banham, Univ. of British Columbia (Canada), 1983.

Diagenesis and Reservoir Qualities of the Jurassic Navajo (Nugget) Sandstone in Utah and Southwestern Wyoming, Kadir Dygur, Univ. of Utah, 1983 (GAX83–25942).

Differentiation of the Nebo Granite (Main Butterfield Granite), South Africa, Dennis R. MacCaskie, Univ. of Oregon, 1983 (GAX83–25284).

Effect of Organic Pore Fluids on the Fabric and Geotechnical Behavior of Clays, Eileen D. Gilligan, Syracuse Univ., 1983 (GAX83–25284).

Books

Carbon Dioxide and Climate: A Second Assessment

Report of the CO_2/Climate Review Panel, National Research Council, National Academy Press, Washington, D. C., xx + 72 pp., 1982.

The Long-Term Impacts of Increasing Atmospheric Carbon Dioxide Levels

G. J. MacDonald (Ed.), Ballinger, Cambridge, Mass., xxiv + 252 pp., 1982, $35.

Reviewed by A. Berger

Introduction

There are quite a large number of excellent publications now available in the domain of carbon dioxide and climate. After a period of intense research on the subject conducted under the sponsorship of national and international institutions like the U.S. National Research Council, the U.S. Department of Energy, the Environment Agency of the Federal Republic of Germany, the Scientific Committee on Problems of the Environment, the International Institute for Applied Systems Analysis, the World Climate Program, the Commission of the European Communities and others, syntheses are now possible.

Over the past decades, extreme climatic events in different parts of the world have made us aware of our vulnerability to climatic variations and variability. But it is also more and more recognized that not only man may possibly be affected by climate but also that climate is vulnerable to man's activities. These human activities, especially those related to industrial processes and the practice of agricultural burning and soil management, result in the release of particles and trace gases in the atmosphere. The increase of atmospheric CO_2 which is worldwide poses a special problem of major concern.

Since the beginning of industrialization in the last century, a steady increase in energy consumption was observed with a growth rate of about 5.3% per year. The history of carbon dioxide production from fossil fuel combustion and cement production is related to the history of global energy demand: their rate of growth, at least before the energy crisis, was slightly less than 4.3%. The fraction of CO_2 emissions remaining airborne is around 50%; although this amount is variable from year to year, it resulted in an increase of the atmospheric CO_2 level by about 20% since the beginning of the industrial era: The pre-1850 value is estimated to be 260 parts per million by volume (ppmv); it was 290 ppmv around 1900 and the 340 ppmv value was exceeded for the first time in 1981 (which represents roughly 710 Gtonnes of carbon as carbon dioxide in the atmosphere). If energy consumption follows current projections, it seems probable, based on present knowledge of the carbon cycle, that atmospheric CO_2 will increase to a level of about 380 ppmv by the end of the century and reach twice the pre-industrial level around 2050 A.D. or even 2080 A.D. (Th. D. Potter, *World Climate Program Newsletter, 4*, 1983). This will inevitably lead to changes in the climate system and present estimates center around a global average value of 2–3°C surface air temperature increase per doubling of atmospheric CO_2 concentration, with a 3–4 fold temperature increase in northern polar regions. However, due to the inertia of the oceanic response, temperature increases are expected to follow the CO_2 increase with a lag of 10–20 years.

The NRC Report

In screening the existing knowledge, *Carbon Dioxide and Climate: A Second Assessment* (the report of the CO_2-Climate review panel of the U.S. National Research Council, chaired by J. Smagorinsky of the Geophysical Fluid Dynamics Laboratory), concluded that previous results published in the Charney report (Climate Research Board, 1979), which inferred a relationship between man-made changes in atmospheric composition and substantial climate effects, remain unchanged: "An increase of carbon dioxide in the atmosphere by a factor of 2 would cause the average global surface temperature to increase by 3 ± 1.5°C and no overlooked or underestimated physical effects were found that could reduce this currently estimated global warming to negligible proportions or reverse them together."

This report focuses only on the climatological aspect of the CO_2 problem and conclusions were drawn principally from the present-day numerical models of the climate system. There are 4 main chapters:

1. Introduction and overview, dealing with some historical background of the CO_2-climate research;

2. Principal scientific issues in modelling studies, where the global climate sensitivity is analyzed from simplified models and empirical approaches; the role of the ocean in the transient response of climate and of sea-ice is discussed; the cloud effects are treated through the cloudiness-radiation feedback and the stratus-sea-ice interactions; trace gases other than CO_2 and atmospheric aerosols are recognized as providing another potentially significant and complex source of climate variability; and finally the need for model validation, their current state and their improvement are reviewed.

3. Predictions and scenarios of climate changes due to CO_2 increases, where the global-average, the zonal, and the geographic *responses to scenarios of CO_2 increase* are investigated not only through a 1-dimension radiative-convective model but also through comprehensive General Circulation Models of the joint ocean-atmosphere system. Various observational studies are shown to provide a useful starting point for diagnosis of climatic processes that may prove to be relevant to the CO_2 problem, but have certain problems and limitations that deserve comments.

4. Early detection strategies and monitoring of the ocean climate response, where it is suggested that early indications of CO_2-induced changes can perhaps be found in zonal-mean summer temperatures in the stratosphere and mesosphere, in satellite remote temperature sounding data, in the temperature of the deep ocean layers, in the weighted mean global mass integral of the atmospheric temperature or in the sea-ice extent. However, the early detection of the CO_2-climate signal requires not only a prediction of the CO_2-induced climate change but also a knowledge of the natural climate variabilities. Therefore, operational monitoring of the ocean and atmosphere is not only required but it is also necessary to determine from the past climatic records the variability of relevant climate variables.

NRC Conclusions

In summary, the panel reached the following conclusions.

(1) The sensitivity of global-mean temperature to increased atmospheric CO_2 estimated from simplified models is generally consistent with that estimated from more complete models.

(2) Global-mean surface warming is driven by radiative heating of the entire surface-atmosphere system; land surface processes interact with climatic changes in ways that are yet poorly understood.

(3) The heat capacity of the upper ocean is potentially great enough to slow down substantially the response of climate to increasing atmospheric CO_2.

(4) The lagging ocean thermal response may cause important regional differences in climatic response to increasing CO_2.

(5) It is premature to draw conclusions regarding the influence of clouds on climate sensitivity to increased CO_2.

(6) The climatic effects of alterations in the concentrations of trace gases can be substantial.

(7) Atmospheric aerosols are a potentially *significant* source of climate variability, but the climatic impact of their changes cannot currently be determined.

(8) Comparisons of simulated time means of a number of climatic variables with observations show that modern climate models provide a reasonably satisfactory simulation of the present large-scale global climate and its average seasonal changes.

(9) Observed surface temperatures of Mars, earth, and Venus confirm the existence, nature, and magnitude of the greenhouse effect.

(10) Model-derived estimates of globally, and perhaps zonally, averaged temperature changes appear to have some predictive reliability for a prescribed CO_2 perturbation.

(11) Observational studies play an important role in the formulation and the general validation of models, the construction of climate scenarios, and the determination of the natural climatic background against which a CO_2 man-induced climatic change will have to be tested.

In the frame of its conclusions, the panel has come to recommend the following research and action:

(1) Theoretical and empirical studies of the climatic effects of increased CO_2 must properly account for all significant processes involved, notably changes in the tropospheric energy budget and the effects of ocean storage and atmospheric and oceanic transport of heat.

(2) Empirical approaches to estimating climatic sensitivity, particularly those employing satellite radiation budget measurements, should be encouraged.

(3) The role of the ocean in time-dependent climatic response must receive special attention in future modeling studies.

(4) Future efforts should be directed toward the further improvement of the parameterizations of physical processes that are poorly understood at present, i.e., cloud formation, moist convection, and land-surface processes.

(5) The most radiatively significant trace gases must be monitored.

(6) The climatic impact of changes in anthropogenic aerosols must be better determined.

(7) A comprehensive climate model validation effort must be pursued.

(8) Further analyses and diagnostic studies based on past and contemporary climatic data sets should be encouraged.

(9) A set of indices that have a large signal-to-noise ratio with respect to CO_2-induced changes should be identified and monitored.

(10) CO_2 transient response experiments and CO_2 *climate equilibrium* sensitivity experiments must continue. The investigation of the transient response from ocean-atmosphere general circulation must be pursued.

(11) To determine the geographical details of a CO_2 induced climate change, it would be necessary to develop climate models with improved computational resolution.

This very clear report, written in a concise format, provides not only an excellent view of the most recent results on the CO_2 impacts on climate but also analyzes critically the limitations of the present models and observation data set. Accordingly, the experts of the panel concluded with recommendations which are going to be landmarks for research in the future.

A Broader Look

The Long-Term Impacts of Increasing Atmospheric Carbon Dioxide Levels, edited by G. J. MacDonald, is much broader in scope than the National Academy report: it does not limit itself to climatic impacts but covers also sources and sinks for carbon dioxide (part 1), models of climate change resulting from changes in the chemical composition of the atmosphere (part 2), some consequences of changing the composition of the atmosphere and research needs (part 3).

In fact, the book is built to document the following statement (p. xxiii): "Since carbon dioxide is transparent, or almost so, to sunlight but absorbs energy radiated by the earth in the infrared part of the spectrum, carbon dioxide plays a key role in determining the mean temperature of the atmosphere, its variation with height and latitude, and thus the climate of the earth. Carbon dioxide can also affect the rate at which plants grow and store carbon. Reacting with water, carbon dioxide can change the acidity of rivers, lakes, and oceans and possibly perturb biological activity."

Significant uncertainties exist in the four main aspects of the CO_2-climate problem: (1) the rate of CO_2 production, both natural and man-made (the latter by an increasing energy consumption due to improvement of life conditions and expansion of world population); (2) the increase of atmospheric CO_2, which is related to the carbon cycle; (3) the modeling of the climate, and (4) biosphere response to changes in atmospheric CO_2 concentration. The possible benefits and costs of these changes to society fully justify the need for such a book, which considerably helps to better understand the overall CO_2-climate model and its weaknesses.

Chapter 2 discusses the contribution to atmospheric carbon dioxide due to the burning of a wide range of natural and synthetic fuels. The values listed must be used with caution as some more efficient land uses produce less amount of carbon per unit of thermal or electric energy generated: a conventional, coal-fired electrical power plant releases 5 times as much carbon as natural gas does, synthetic gas and oil roughly 3 times, and natural shale oil and coal around 2 times (methane releases 13.8 kg carbon per 10^9 J, more or less the same as does hydrogen from natural gas reforming). Future fuel uses are then estimated to provide a base for future *atmospheric levels of carbon dioxide*. Unfortunately only two consecutive scenarios are considered: (1) with the present fuel mix, 1400 additional Gtonnes of carbon will be deposited to the 1978 atmosphere by the year 2035 if the historical growth rate is maintained; (2) with a tapered growth rate (historical growth rate maintained to 1990 and then decreasing linearly to zero over the fifty-year period 1990–2040), the date is pushed forward 20 years. A comparison with much more efficient scenarios, as described in Bach (*Progress in Physical Geography, 6*(4), 549–560, 1982), would have been of real interest; for example, for the 16 EW Commission of European Communities scenario, the cumulative carbon emitted into the atmosphere since 1978 would be only 350 Gtonnes by 2035.

As the terrestrial and marine biosphere act as a source and sink for carbon dioxide and as the carbon cycle is closely coupled in nature to the oxygen cycle, the following matters are then reviewed in chapter 3: the response of natural vegetation to increasing atmospheric CO_2 (also in chapter 15), the effects of deforestation erosion, the eutrophication of the ocean, the oxygen balance sheet, the minor reactions contributing to the oxygen cycle and oxygen in the ocean (e.g., natural oxygen deficit of the oceans not only amounts 5000 Gtonnes but is increasing at a rate of 10 Gtonnes of oxygen per year, which remains to be explained through direct and indirect effects of human activities).

The rate at which the ocean can absorb carbon dioxide, depending on how the surface layers of the ocean mix with the deeper parts, is simulated through the Pips Model which emphasizes the physical, biological, and chemical processes at the ocean boundaries, an interesting hydrodynamic analog due to Revelle to the more usual diffusive box models.

Estimating Future Levels

For estimating the future levels of CO_2, a model of the atmosphere-biosphere-ocean interactions is presented in chapter 5, where the importance of the biosphere and oceanic uptake of carbon and the possible feedback from large carbon reservoirs are illustrated. The dates on which the carbon dioxide content doubles range from 2033 to 2085, depending on the assumed absorption capacity of the oceans and biosphere and whether the carbon-based fuel contribution grows at a ta-

Books (cont. on p. 54)

Books *(cont from p. 93)*

pend rate and the present fuel mix is maintained. But, given the large uncertainties indicated and only the two energy scenarios used, 2045 appears to be a reasonable estimate, which is distinctly at the pessimistic side when compared with the more recent projections of about 2070. Furthermore, a worldwide warming will tend to produce a positive feedback releasing carbon from the soils, methane hydrates, and the oceans, although there remains uncertainty as to whether these large carbon pools will play a significant role in enhancing the CO_2-induced climate change.

Chapters 6, 8, and 9 review the fundamentals for simulating changes in the planetary heat balance from chemical changes in the atmosphere, considering models of the atmosphere in which radiation is the only mechanism by which energy is transferred. The equivalent grayscale radiative atmosphere gives a $\Delta T_s = 2.8$ K if the CO_2 content were doubled. A zonal energy balance model and a simple band model for infrared emission from the terrestrial atmosphere show that the ΔT feedback from the additional water burden that the atmosphere can support in maintaining a constant relative humidity, is comparable to the ΔT produced directly by an increase in CO_2. This illustrates the importance of the water vapor feedback which was clearly demonstrated by Ramanathan (*Journal Atmospheric Sciences, 38*(5), 918–930, 1981). The primary contribution to the (2 x CO_2) surface warming (2.2°C) is indeed from the enhanced tropospheric IR emission due to the increased evaporation from the warmer ocean in a CO_2-rich atmosphere (1.7°C).

This is an order of magnitude greater than the direct CO_2 radiative heating at the surface (0.17°C), the third process involved being related to the downward component of the amplified atmospheric IR emission (0.34°C).

The addition to the atmosphere of minor constituents that absorb in the 8 to 12 μm band could also be important (chapter 7): An increase of 10× times would place the freons in the climate crucial category; for both nitrous oxide and methane, which sit in regions where there is already strong absorption, factors of 2 are important. Although uncertainties do exist in the strength of future sources, in the atmospheric chemistry, and in the atmospheric feedbacks, an additional 1.5 K increase in average surface temperature is anticipated in the mid-21st century as a result of an increase by a factor of 2 in CH_4 produced mainly from the anaerobic fermentation of organic material: 0.4 K); 1.5 in N_2O (essentially due to the use of ammonium based fertilizers, 0.4 K); 10 in freons (0.1 K); 1.5 in CO (a by-product of the incomplete combustion of hydrocarbon fuels; 0.6 K); and 15 in CFCl (mainly released from the electrolytic reduction of aluminum; 0.4 K).

Human Impacts

Finally, part 3 is devoted to some particularly important consequences of man's impacts on the composition of the atmosphere. After a short discussion on the use of models to predict climate (chapter 10), the latitudes dependance of the changing temperature is discussed (in chapter 11) with its effects on the distribution of sea-ice and as a result, on the ocean circulation and on the marine biosphere. For example, an increase of 3°C in average ocean temperature by 4°C would ultimately release about one-seventh of the presently dissolved CO_2 content of the atmosphere and a polar CO_2-induced warming will probably weaken the deep water pumps, although its sensitivity remains very hard to assess.

The impact of the warming on the most vulnerable part of the Antarctic ice mass, the West Antarctic ice sheet grounded below sea level, is then considered in chapter 12, a useful review of the basic physics of ice flow and creep being given in the appendix. On the basis of very simple mechanical considerations, the creep thinning of marine-based ice streams could be fast enough to draw down the ice sheet in as little as 100 years, but the question of whether a polar warming due to CO_2 doubling could increase ice shelves sufficiently to initiate such much more dramatic motion has no clear answer at the moment. Immense attention because of other crucial events triggered, namely the 5 m rise in sea level.

Finally, an increase in the CO_2 content of the atmosphere will increase the carbon that is available for fixation by photosynthesis and change the climatic conditions, both changes altering net primary productivity. The nonclimatic effects of CO_2 as a nutrient of agricultural and natural plants may be at least as important as the climatic effects and needs better attention. For example, in addition to its possible effect as a fertilizer, the CO_2 produced by fossil fuel burning may also be helping to increase agricultural yields by reducing the water demand of crop plants in dry areas.

A summary ends this excellent book by focusing on

(1) the role of the biosphere in the carbon cycle (e.g., more detailed statistical analyses using observed climatic changes are required before the impact of climatic change on the biosphere can be predicted),

(2) the role of the soils and hydrates of methane,

(3) the role of climate models, intermediate in complexity between heat budget models (which cannot provide the details on the climatic parameters which are essential in assessing the long-term impacts on activities such as agriculture) and the global circulation models (whose complexity may hide the underlying physics and which related numerical approximation employed may distort the long-term interactions),

(4) the timing and place where rise in mean temperature will occur (summer or winter, night or day) and its effect on local extremes,

(5) the effort in monitoring trace constituents which can enhance the greenhouse effect,

(6) detecting the secular temperature trend against the noise background, and

(7) the worldwide nature of the CO_2 question.

Although the climate system possesses many resilient qualities, man's activities may well alter greatly the future climate and in consequence our society itself. It therefore behooves us to not let this experiment, the greatest inadvertent geophysical experiment ever begun, proceed unobserved and uncontrolled. These two books will undoubtedly help multidisciplinary interchanges among the overall community involved in this CO_2 problem. Read them.

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Seismic Reflection Interpretation

A. H. Kleyn, Applied Science, New York, xii + 269 pp., 1983, $57.50.

Reviewed by Larry D. Brown

This interesting, albeit uneven, little book reviews a broad range of topics related to the collection and analysis of seismic reflection data. In spite of its misleading title, it deals less with the geological interpretation of reflection sections than with the geometrical analysis of seismic raypaths. For example, statics corrections and migration theory—topics of peripheral interest if not indifference to most interpreters—are subjects of entire chapters while seismic stratigraphy, one of the hottest current branches of interpretation, is not even mentioned!

Title semantics aside, a glance at the table of contents confirms that most of the obligatory topics of an overview are covered: An introduction (chapter 1, brief to the point of extinction!) is followed by a "Review of Basic Principles" (chapter 2) in which refraction, reflection, diffraction, Snell's Law, Fermat's Principle, Fresnel zones, reciprocity, snapling theory, travel-time curves and f-k filtering are variously, though curtly, discussed. chapter 3, "Geometrical and Analytical Backgrounds," gets to the ray tracing considerations while lie at the heart of this book, deriving time distance relationships for reflections and refractions in layered and continuous media as well as discussing CDP data collection technique, NMO and velocity analysis, and multiple reflections and areal surveys. "Static Corrections" are the subject of chapter 4, and chapter 5 ("Reflection, Transmission, and Acoustic Impedance), reviews basic concepts including a discussion of the convolutional model of reflection response and Gassman's equation for acoustic impedance in porous media. Chapter 6 ("Velocity Measurement in Wells") delves into well logging and its relation to seismic sections. Chapter 7 ("Structural Interpretation of Reflection Information") attacks the meatier topics of migration geometries in 2 and 3 dimensions, including time-to-depth conversion, and is supplemented in chapter 8 ("Elements of Signal Migration Systems") by a review of Kirchoff and finite element approaches to computer migration.

The book's primary appeal lies in its fresh presentation of consideration which have been either neglected or inadequately addressed in other texts. The flavor of industry experience enhances many of the treatments. The frequent incorporation of 3-dimensional considerations in discussion of analytical and processing procedures is especially welcome, although the 3-D diagrams are among the most confusing in the book, and the vector notation is abruptly introduced. The treatment of reflection time derivatives, examples of spurious f-x relations from such phenomena as reflected diffractions, time ties at line crossings, and the relationship between the various types of velocity measures are particularly insightful. Some relatively mundane topics like NMO stretch also receive an unusual airing. The overview of well logging is well done, with a discussion of well shooting as well as acoustic logging. The treatment of migration and structure is particulary thorough with respect to the geometrical aspects, including migration of time contour maps and 3-D data with the usual examples comparing unmigrated and migrated responses of basic structures. A discussion of migration before stack in chapter 8 also deserves attention. An especially useful aspect of this book is the inclusion of numerous exercises with solutions (referred to in the book as examples) whose problems are unusually fresh and often more informative than the accompanying text. Also particularly handy are the numerous bibliographical references at the end of each section, although the use of volume numbers in lieu of page numbers is annoying. Lastly, the numerous seismic sections (lumped, for some unexplicable reason, at the end of the book rather than inserted where they are discussed) are excellent and exceedingly well reproduced.

Unfortunately, the treatment of many of these topics is uneven and often sketchy. According to the preface, the book is based on a series of industry lectures, which may account for the frequent impression of that one is reading supplementary notes rather than a fleshed-out text. Many of the basic relations are briefly derived, if at all, and important equations often appear with "it can be shown that"-type introductions. Although this brevity may have been an intentional effort to skirt introductory material which can be found elsewhere, the resulting incompleteness will impede readers not already familiar with the material. Many of the figures are unnecessarily confusing, usually because of poor annotation and incomplete discussion. To cite but one example: Explanation of how multiple channels are used to collect data in the CDP roll-along manner is relegated to a single, confusing figure of a stacking chart that would baffle anyone not already aware of how roll-along works. There are no true synthetic seismic sections (only travel-time sketches), although they would prove most informative in illustrating many of the principles. While such explanatory omissions might be acceptable when addressing an experienced industry audience, they seriously detract from this book's utility as a general purpose text.

Another detraction is the uneven and often curious emphasis of topics. Statics corrections are given a separate chapter, while all other aspects of seismic data processing are lumped under a background chapter. Even the discussion of statics is uneven: Much residual statics barely rates a mention. Resolution, deconvolution and anelastic attenuation are also barely mentioned. Although refraction is discussed at length, the traditional basic equations for interpreting thicknesses and dips in layered media never appear, except implicity buried in less useful (from the interpretation viewpoint) equations.

Even the more laudable discussions seem incomplete. For example, after expending considerable worthwhile prose describing various velocity measures, the author virtually skips through a discussion of the various methods for making such measurements, showing no examples of the most commonly used techniques such as velocity spectra. The computation of various time derivatives which I found rather elegant, is left hanging with no real attempt to point out their physical meaning or usefulness. The problem of vertical time-to-depth conversions seems to me to be unnecessarily entangled with migration aspects, without a clear explanation of the relationship. There is no mention of frequency domain migration although an entire chapter is devoted to Kirchoff and finite difference methods. Although several aspects of seismic data processing are addressed, the treatment is too scattered and incomplete to provide a useful overview of this aspect of reflection seismology. In spite of their excellent quality, the appended seismic sections are little discussed, except to illustrate a few rather limited points. Most of sections exhibit a number of interpretational principles worthy of much more discussion.

Although this book attempts to cover much of the methodology of the reflection seismology, it is too sketchy and uneven to serve alone as an introductory or reference text. Yet its treatment of selected aspects is too useful and novel to overlook. As a supplementary or perhaps refresher text, it is worth the attention of even experienced exploration geophysicisis.

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For more information, call **202-462-6903 or toll free 800-424-2488.**

POSITIONS AVAILABLE

Postdoctoral Fellowship: Hydrogeology. Applications are invited for a postdoctoral position at the University of British Columbia. Starting date: July 1, 1984; two years, with possible extension for a third year. Specific research task will require familiarity with hydrogeologic environments, contaminant transport, and numerical modeling. Open to candidates from Geology or Engineering. Salary: at least $20,700 Canadian. Applications with resumes and addresses of three referees should be sent to: Dr. R.A. Freeze, Department of Geological Sciences, University of British Columbia, Vancouver, B.C., Canada, V6T 2B4. For further information, telephone (604) 228-6662.

Research Position in Space Plasma and Auroral Physics. Two research positions at the level of assistant or associate research scientists are available in the Department of Physics & Astronomy at the University of Iowa for qualified candidates with a Ph.D. degree and experience in space plasmas and/or auroral physics. Present research in space plasma physics emphasizes analysis and interpretation of observations of magnetospheric plasmas using instrumentation on board earth-orbiting spacecraft in the IMP and ISEE Missions. The University of Iowa's global imaging instrumentation on the spacecraft Dynamics Explorer 1 is the source of an extensive data base of auroral images from high altitudes at visible and ultraviolet wavelengths. Photometric observations are also available for other areas of research including the physics of the upper atmosphere and the global distribution of atmospheric ozone. The applicant should identify and describe areas of his or her expertise which can support experimental or theoretical investigations in space plasma physics and/or auroral physics. Salary and position will be determined by the applicant's qualifications and experience.

A resume and the names of three persons knowledgeable of applicant's experience should be forwarded to: L.A. Frank, Department of Physics & Astronomy, University of Iowa, Van Allen Hall, Iowa City, Iowa 52242.

The University of Iowa is an affirmative action/ equal opportunity employer.

Program Manager/Air-Sea Interaction. NASA Headquarters' Oceanic Processes Branch is seeking candidates for planning, developing and implementing a scientific research program utilizing satellite techniques in the general area of air-sea interaction. Specifically included is the use of satellite scatterometry to characterize the surface wind field, and the effect of surface winds on upper-ocean currents. Qualifications include 1) ability to communicate effectively, 2) demonstrated experience in conducting original research, 3) program management experience, and 4) knowledge of physical oceanography. GS 13/15, with salary ranges from $41,277 to $63,115, commensurate with experience/education. For further information regarding requirements and application procedures write or telephone before or phone 202-755-3687. Formal applications must be received by May 6, 1984.
NASA Headquarters, Code NHP, Washington, D.C. 20546.
An equal opportunity employer.

University of Oklahoma/Electronics Instrumentation Specialist. The School of Geology and Geophysics is accepting applications for a full-time Electronics Instrumentation Specialist. The principal responsibilities will include maintenance, calibration and user instruction for a new, computer-automated Rigaku XRD-XRF system, and maintenance and repair of electronic components of other lab facilities in the School. Additional opportunities could include involvement in the University's electron microscopy lab (SEM and TEM), and the development of a Vax/de GraPLINE analytical system in collaboration with O.U. physicists. Applicants should have a B.S. in Geology, Chemistry, or Electrical Engineering or equivalent in experience; salary is commensurate with qualifications. Send curriculum vitae and names and addresses of three professional references to:

Dr. David London
School of Geology & Geophysics
University of Oklahoma
Norman, Oklahoma 73019
Deadline for applications is March 15, 1984.
The University of Oklahoma is an affirmative action/equal opportunity employer.

Assistant Professor of Geophysics/Purdue University. The Department of Geosciences, Purdue University anticipates an opening for a new tenure track position at the assistant professor level in the area of exploration geophysics. The successful applicant must be prepared to assist in teaching exploration geophysics courses, advanced topics in his/her specialty, and demonstrate an ability to develop and conduct productive research. Postdoctoral or industrial experience is desirable. The geophysics program in the Department of Geosciences at Purdue University currently consists of four full-time geophysics faculty. Field and laboratory equipment and facilities are available for application to seismological and potential field geophysical methods. Excellent computing facilities including a Cyber 205 computer operated by Purdue University and mini-computers within the Department of Geosciences are available.

Send letter of application including brief description of research interest and goals, resume and names of three references to:
Don W. Levandowski, Department of Geosciences, Purdue University, West Lafayette, Indiana 47907.
Closing date for acceptance of application is May 1, 1984 or until the position is filled.
Purdue University is an equal opportunity/affirmative action employer.

Clay Mineralogy/University of Illinois at Urbana-Champaign. The Department of Geology invites applicants for a tenure-track faculty position in clay mineralogy. We are seeking candidates who have clearly demonstrated the potential to be outstanding but broader opportunities also exist for self-motivated projects within the University or at Bedford Institute of Oceanography. A Ph.D. in geophysics and desire to work 1-2 mos/yr at sea are required. Experience with heat flow helpful but not essential. Send C.V. and names of two references to: Dr. K. F. Louden, Dept. of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4J1.

Upper Atmosphere Research: USRA Visiting-Scientist/Research-Associate Program at NASA Marshall Space Flight Center. The Universities Space Research Association (USRA) invites applications for a research position in its Visiting-Scientist/Research-Associate Program at NASA Marshall Space Flight Center, Huntsville, Alabama, in the Atmospheric Sciences Division of the Systems Dynamics Laboratory. The research will consist of theoretical studies, data analysis, and modeling of the earth's neutral atmosphere above 70 km altitude in collaboration with NASA/MSFC scientists. We seek particularly well-qualified applicants from recent graduates with the Ph.D. degree in atmospheric science, or a related discipline, consideration will also be given to holders of the Masters degree with appropriate experience. The appointment will be for one year (renewable); salary is competitive.

Applicants should submit a comprehensive resume and names of three references to: Dr. M. H. Davis, USRA, P.O. Box 3006, Boulder, CO 80307.
USRA is a non-profit consortium headquartered in Columbia, Maryland, sponsored by NASA contract.

The Association is an Equal Opportunity/Affirmative Action Employer.

Research Associates. The Department of Earth and Space Sciences at SUNY Stony Brook invites applications for a Research Associate position. Candidates should be experienced in application of Electron Microprobe and Analytical Electron Microscope techniques to geologic materials. The Department has a JEOL 2000 Electron Microscope with EDS and will be purchasing a new Electron Probe in 1984. Duties will include equipment maintenance, instruction of graduate students on equipment use and research in their own interest. A CDC system and Unix facility. Familiarity with computers and Fortran programming required. A PhD is preferred. Salary is negotiable, but we anticipate a range of $18–25k.

Send letter of application, resume and names and addresses of three references by March 31, 1984 to Dr Steven Bohlen, Department of Earth and Space Sciences, SUNY Stony Brook, NY 11794.

SUNY Stony Brook is an equal opportunity affirmative action employer. Ak 9-7-81

NASA/Space Plasma and Magnetospheric Physics. There is an opportunity to become involved in state-of-the-art data management issues, techniques, and solutions while simultaneously doing research interests. The National Space Science Data Center at the Goddard Space Flight Center is in an evolving transitional period and has the rare opportunity to contribute significantly to the development of new data management systems for space plasma and magnetospheric physicists. These individuals will join with several others in attacking a broad range of data management problems, including: facilitating access to and index of space science data in an evolving technological environment. These activities include development of an online data catalog, interfacing with Principal Investigators and spacecraft project officers for data accessibility and documentation, preparing data catalogs, generating techniques for coordinated multi-spacecraft data acquisition and index, and generation of composite or other value-added data sets. Research interests are encouraged and may be pursued on a substantial part-time basis. A Ph.D. is preferred, although a Master's degree will be considered for some activities. Experience with space flight experiments, data analysis techniques, data presentation, publications, and programming is highly desirable. Specific duties will depend upon an individuals background and interests.

Send resume to:
Dr. H. Kent Hills
Sigma Data Services Corp., a MDA-COM Co
Code 601
National Space Science Data Center
NASA-GSFC
Greenbelt, Md. 20771
Sigma Data Services Corp., a MDA-COM Co. is an equal opportunity employer.

Postdoctoral Position/Dalhousie University. A two-year position in the Oceanography Department is available for a person interested in marine geophysics. Specific work involves participation in heat flow studies across the margins of eastern Canada; researchers in the area of paleoceanography, tectonics, etc. are encouraged to participate. Opportunities also exist for self-motivated projects within the University or at Bedford Institute of Oceanography. A Ph.D. in geophysics and desire to work 1-2 mos/yr at sea are required. Experience with heat flow helpful but not essential. Send C.V. and names of two references to: Dr. K. F. Louden, Dept. of Oceanography, Dalhousie University, Halifax, NS, Canada, B3H 4J1.

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Applicants should submit a comprehensive resume and names of three references to: Dr. M. H. Davis, USRA, P.O. Box 3006, Boulder, CO 80307.
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Send resume to:
Dr. H. Kent Hills
Sigma Data Services Corp., a MDA-COM Co
Code 601
National Space Science Data Center
NASA-GSFC
Greenbelt, Md. 20771
Sigma Data Services Corp., a MDA-COM Co. is an equal opportunity employer.

University of South Alabama. Faculty Position. Tenure-track position at the rank of Assistant Professor in one of the areas following: Stable Oil Isotope Paleontology-Stratigraphy, 12) Igneous OR Metamorphic Petrology. The University of South Alabama has approximately 10,000 students, and is located in a growing metropolitan area. The Department of Geology and Geography has approximately 200 majors, and a faculty of nine full-time and three part-time members. This position is to be filled commencing September, 1984. The deadline for applications is May 15, 1984. Please submit letter of application, along with a resume of your education and experience, to: D. Gerald Strain, Chairperson, Department of Geology and Geography, University of South Alabama, Mobile, AL 36688. Also arrange to have at least three letters of reference sent to the same address.

The University of South Alabama is an equal opportunity, affirmative action employer.

Faculty Position/Florida Atlantic University. The Physics Department is seeking applicants for an experimental physicist to commence his position at the Assistant Professor level beginning August, 1984.

Candidates must have a Ph.D. degree and have demonstrated a commitment to research and teaching. Preference will be given to candidate with experience in experimental atmospheric physics, optics, or solid state physics.

Salary is negotiable. Deadline for applications: April 15, 1984. Contact: Dr. Byron Leibowitz, Chairman, Department of Physics, Florida Atlantic University, Boca Raton, FL 33431. (305) 393-3481. Florida Atlantic University is an affirmative action/equal opportunities employer.

Colgate University. The Department of Geology at Colgate University anticipates one or more openings in the teaching faculty beginning in the Fall of 1984. These openings may include a full-time appointment responsible for a maximum of three years at the assistant professor level (Ph.D. required). A second position at the instructor level would involve part-time basis. A Ph.D. is preferred, although a Master's degree will be considered for some activities. Experience with space flight experiments, data analysis techniques, data presentation, publications, and programming is highly desirable. Specific duties will depend upon an individuals background and interests.

Send resume to:
Dr. H. Kent Hills
Sigma Data Services Corp., a MDA-COM Co
Code 601
National Space Science Data Center
NASA-GSFC
Greenbelt, Md. 20771
Sigma Data Services Corp., a MDA-COM Co. is an equal opportunity employer.

Air Force Geophysics Laboratory Geophysics Scholar Program (1984–1985). The Air Force Geophysics Laboratory (AFGL) and The Southeastern Center for Electrical Engineering Education (SCEEE) announce that applications are invited for research appointments during the 1984–1985 year in the Geophysics Scholar Program. This program provides research opportunities of 10 to 12 months duration for selected Engineers and Scientists to perform research in residence at the AFGL, Hanscom AFB, near Boston, Massachusetts. Scholars will be selected primarily from such fields as Geophysics, Atmospheric Physics, Meteorology, Ion Chemistry, Applied Science, Mathematical Modeling using Computers, and Engineering.

To be eligible, candidates must have a Ph.D. or equivalent experience in an appropriate technical field. Some appointments may be confirmed prior to August 1984 so early applications are encouraged. All qualified applicants will receive consideration without regard to race, color, religion, sex, or national origin. Application Deadline for September Appointments: August 1, 1984. For further information and application forms contact: SCEEE, 1101 Massachusetts Avenue, St. Cloud, FL 32769. Telephone (305) 892-6146.

SCEEE supports Equal Opportunity/Affirmative Action.

Geophysicist/University of Minnesota. The Department of Geology & Geophysics invites applications for a tenure track position in solid earth geophysics beginning fall 1984. We seek a Ph.D. and preferably some postdoctoral experience. The field of interest is open but includes, for example, gravity, magnetics, global and regional tectonics and the physical state of the crust and mantle.

Present research programs in geophysics include geomagnetism and paleomagnetism, mineral physics at high pressures, and crustal seismology. We also emphasize the interconnectedness of geophysics with the in-house strong programs in aqueous and isotopic geochemistry, tectonics, and limnology.

Please submit a letter of application and attach a curriculum vitae, statement of research and teaching interests, a list of publications and the names of three to four references by March 15, 1984 to: Subir Banerjee, Department of Geology and Geophysics, 310 Pillsbury Drive, S.E., University of Minnesota, Minneapolis, MN 55455.

The University of Minnesota is an equal employment opportunity affirmative action employer and encourages applications from qualified women and minorities.

Agricultural Drainage. Assistant, associate or full professor joint tenure track faculty position in the Departments of Land, Air and Water Resources and Agricultural Engineering. Qualifications are a doctorate in soil and water engineering, soil physics, or related field. At least one degree in engineering desired. Applicants must have strong background in water flow and solute reactivity in porous media, mathematical and computer simulation modeling, and course work and/or experience in engineering design and evaluation of agricultural drainage systems.

Teaching includes two undergraduate courses: a background course in water and solute transport and descriptive treatment of drainage systems and a course in design and evaluation of drainage systems. Additional teaching duties include advising of undergraduate and graduate students. The appointee, after the research program is established, will be expected to offer a graduate course in that research area. Research involves study of processes in the management of soil salinity and shallow groundwater, including irrigated croplands.

Applicants should submit curriculum vita, transcripts, statement of research and teaching interests and background in each, copies of publications and manuscripts, abstract of dissertation and the names and addresses of at least three references to: Professor D. R. Nielsen, Chair, Search Committee, Department of Land, Air and Water Resources, 121 Veihmeyer Hall, University of California, Davis, California 95616, by March 30, 1984. Position is available immediately.

The University of California is an affirmative action/equal opportunity employer.

Space Plasma Theoretician/Princeton University. A postdoctoral position is available beginning summer of 1984 in the Theoretical Division of the Plasma Physics Laboratory, Princeton University, for one year with the possibility of renewal for a second year. Physicists with a Ph.D. degree or its equivalent in other relevant discipline are encouraged to apply. The position involves theoretical and numerical simulation studies on space plasma physics under the support of the National Science Foundation. Interaction with the members of the Laboratory engaged in fusion plasma physics is encouraged. Interested candidates should send a resume and three letters of recommendation to: Dr. H. Okuda, Plasma Physics Laboratory, Princeton University, Princeton, NJ 08544.

Princeton University is an equal opportunity/affirmative action employer.

College of Oceanography, Oregon State University/Two Faculty Positions. *Sediment Geochemist or Sedimentologist.* 12-month, tenure-track position as an Assistant or Associate Professor in the College of Oceanography. Ph.D. in earth science, marine geology, or marine geochemistry and strong potential or demonstrated ability to conduct grant-funded research required. The appointee will be expected to teach advanced courses in his or her specialty, supervise graduate student research, and develop a strong research program in marine sediments in at least one of the following areas: (1) mineralogy, (2) uranium series/radiochemistry, (3) stable isotope studies as applied to diagenesis, or (4) inorganic geochemistry.

Marine Geologist (Micropaleontology and Stable Isotopes). 12-month, tenure track position as an Assistant or Associate Professor in the College of Oceanography. Ph.D. in earth science, marine geology, or oceanography and have a strong potential or demonstrated ability to conduct grant-funded research required. The appointee will be expected to teach advanced courses in his or her specialty, supervise graduate student research, and conduct a strong research program in marine geology and stable isotopes with emphasis on paleoceanography and paleoclimatology. Send resume and names of three references by April 15 1984 to:
G. Ross Heath, Dean, College of Oceanography
Oregon State University, Corvallis, Oregon 97331
U.S.A.

Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973.

Position in Geophysics (Applied Solid Earth)/University of California, Riverside. Visiting lecturer opening beginning 1 September 1984. Although the initial appointment will be as a Lecturer, and is annually renewable, the appointment could lead to a ladder faculty position the following year. Appointee would teach both undergraduate and graduate level courses in geophysics and tectonics. Ph.D. required, and evidence of excellent potential in basic research in any subfield of applied geophysics will be considered. In addition to teaching, research and service are required of faculty members at the University of California. Applicants should submit a current curriculum vita with names and addresses of three people who have agreed to provide references. Applications should be complete by April 1, 1984; however, late applications may be accepted unil successful candidate is appointed. Send applications to: Dr. Shawn Biehler, Department of Earth Sciences, University of California, Riverside, California 92521.

The University of California is an equal opportunity/affirmative action employer.

Postdoctoral Position/University of Washington. Research Associate (postdoctoral) with background in physical oceanography or atmospheric sciences and interests in dynamical aspects of climate variability. Term of appointment: one (1) year, renewable for a second year subject to the approval of the Council. Closing date: March 15, 1984. Send curriculum vitae and a list of four (4) references to Director, JISAO, c/o Department of Atmospheric Sciences, AK-40, University of Washington, Seattle, WA 98195.

An equal opportunity/affirmative action employer.

POSITIONS WANTED

Mineralogist Geochemist. 31, Dipl., Ph.D., German, US permanent-resident, visa. Lunar (impact, igneous rocks) and terrestrial, (sedimentation, metamorphous rocks) petrographical geochemical/geochronology, broad analytical experience (includes MS, INAA), research experience in US, English/French, fluent, impressive publication record, seeks employment in research, industry or publishing business, *no* geographical restrictions. Please contact: Dr. Reimold, Inst. f. Mineralogy, Corrensstr. 24, D-4400 Munster, FRG.

STUDENT OPPORTUNITIES

Opportunity for Graduate Study in Igneous Petrology/Isotope Geochemistry—Southern Methodist University. The Department of Geological Sciences at Southern Methodist University in Dallas, Texas seeks outstanding individuals interested in a PhD program in igneous petrology and/or isotope geochemistry. The successful applicant should have a strong background in geology, chemistry, and mathematics and an interest in volcanic processes. Research will involve participation in a field-oriented petrological, geochemical, and isotopic study of Late Cenozoic volcanism in the Chilean Andes. For further details and applications please contact either:

Dr. R. S. Harmon (214) 692-3075
or
Dr. M. A. Dungan (214) 692-2752
Department of Geological Sciences
Southern Methodist University
Dallas, Texas 75275.

Meetings

1983 AGU Fall Meeting Report

In only 5 days the AGU 1983 Fall Meeting in San Francisco accommodated more than 3100 attendees and more than 2100 papers. Each of the special all-Union sessions attracted crowds of close to 1100 persons. Except for the 1982 Fall Meeting, which covered 8 days and included the American Society of Limnology and Oceanography (ASLO) Winter Meeting, 1983's was the largest AGU Fall Meeting ever.

The large number of presentations at the 1983 meeting was handled efficiently by assigning more than 40% of the papers to poster sessions, which were to many participants the highlight of the meeting. Poster presentations are becoming extremely good, and some of the more spirited sessions make many oral presentations seem pale in comparison. The sight of some of the world's leading geophysicists chatting over a poster paper with a student attested to one of the advantages of this type of presentation.

If you missed this meeting, plan early to attend the 1984 Fall Meeting, December 3–7, which will again include the ASLO Winter Meeting. It will be held in San Francisco at the Civic Auditorium.

Changes to the 1983 AGU Fall Meeting program and additional, late, and revised abstracts are printed below.

Papers Not Presented

F41-06, T. Scully.

A12-13, C. Ganesh et al.; A12-14, W. H. Beasley et al.; A51-04, D. H. Stedman and C. A. Cantrell; A51-05, D. G. Torr and M. R. Torr; A51-09, R. E. Shetter et al.; A52-11, S. A. McKeen.

G42-09, J. H. Karl; G51-13, R. E. Ziegler et al.

GP11-02, O. Ozdemir; GP11-11, J. L. Roy; GP11-03, D. M. Bubenik; GP41-06, E. K. Grannelmann and D. L. Tin.

H12-01, P. M. Wallis; H22A-13, F. H. Weirezahn; H31C-04, A. Mantoglou and L. W. Gelhar; H31C-09, T. W. Schmid and D. D. Evans; H31C-12, A. D. Russell and E. G. Lappala; H31D-07, G. P. Kemp and J. T. Wells; H52A-02, C. L. Carnahan; H52B-04, C. Helson and E. F. Wood.

O11B-07, A. Huver; O11B-17, P. Flament et al.; O12B-15, J. M. Luck and K. K. Turekian; O21B-07, P. C. Fiedler; O22-15, N. G. S. Freeman; O31B-17, W. B. Owens and B. A. Warren; O31B-18, D. B. Boudra; O31B-22, J. N. Moum and T. R. Osborn; O31B-24, M. S. McCartney; O31B-27, S. L. Bennett et al.; O31B-31, D. L. Evans; O31B-33, G. Reverdin and M. Cane; O31B-34, T. B. McCord et al.; O31B-35, W. K. Melville and R. J. Rapp; O31B-36, D. B. Altman; O41-04, J. N. Smith and K. M. Ellis; O42-14, J. F. T. Saur and W. B. White; O52B-07, C. C. Ebbesmeyer et al.; O52B-10, K. A. Potocki et al.

P32-05, L. W. Esposito; P32-14, F. A. Kruse; P42-14, M. D. Bjorkman.

S11A-14, W. L. Ellsworth et al.; S11A-15, C. Vita-Finzi and G. C. P. King; S11B-28, D. S. Cavit et al.; S12B-02, S. P. Morris et al.; S21A-01, J. A. Collins et al.; S31-08, S. Ganoe and M. Fehler; S32B-04, M. Y. Song; S42A-03, G. Suarez and O. J. Perez; S42A-09, J. R. Kayal.

SA21A-02, S. Matsushita et al.; SA21A-05, M. O. Chandler and C. R. Chappell; SA21A-12, C. Hanuise and J. P. Villain; SA31-02, M. A. Biondi and D. P. Sipler; SA32-10, D. A. Gell et al.; SA42-04, A. I. F. Stewart; SA51-06, J. C. McConnell et al.; SA51-07, R. F. Daniell, Jr. and D. J. Strickland; SA52-12, H. J. Fahr et al.

SC11-07, D. Moses et al.

SM11B-03, B. Hausler et al.; SM12A-05, L. R. Lyons and D. S. Evans; SM12A-15, D. R. Parsignault et al.; SM41C-01, J. V. Olson; SM42A-01, J. L. Horwitz et al.; SM42A-08, D. W. Datlowe et al.; SM51E-37, R. W. Spiro et al.

SS22-08, J. V. Hollweg and B. Roberts.

T22A-01, A. T. Linde et al.; T22A-05, R. B. Grannell et al.; T41C-21, B. C. Haimson and M. Y. Lee; T41C-32, J. Thorne and R. Bell; T41C-33, M. F. Collin and P. D. Rabinowitz; T42A-08, L. S. Cluff; T42C-07, B. Johnson.

V11B-06, D. A. Sverjensky; V21B-03, R. K. O'Nions and E. R. Oxburgh; V21B-08, D. T. Ghahremani and P. O. Banks; V22B-07, R. Zhang; V31A-09, J. D. Friedman; V31B-02, G. Ivarsson; V31B-07, P. J. Kopydlowski; V31B-13, J. Helgason; V32A-11, B. R. Julian and S. A. Sipkin; V41-02, R. B. Waitt, Jr. and N. S. Macleod; V41-05, T. C. Pierson and K. M. Scott; V41-06, R. L. Dinehart; V42A-38, T. H. Pearce; V51B-13, M. S. Weathers et al.; V52B-09, J. D. Morris.

Late and Revised Abstracts

Atmospheric Sciences

A12-23 POSTER

Hy-wire Atmospheric Potential Measurements at 1.5 km

J. WOOSLEY
R. HOLZWORTH (both at Geophysics Program, University of Washington, Seattle, WA 98195)

Continuous Atmospheric Potential measurements with the Hy-wire tethered balloon system have been made for duration of ≈48 hours at 1.5 km altitude and ≈28 hours at 1.1 km. 1-hour averages of the 1.5 km data compare favorably to the Carnegie curve. The 1.1 km data show a similar diurnal pattern with somewhat greater variation from the mean. Furthermore, a clear electric field variation with altitude is seen above a few hundred meters. Charge-discharge time constant measurements indicate that the Hy-wire source impedance is on the order of a few times $10^{10}\Omega$ at both altitudes in agreement with earlier lower altitude measurements. A Carnegie-like pattern is shown by Hy-wire current measurements in the grounded mode, which have typical values of ≈10 μA during the potential minimum and ≈20 μA during the maximum. Ground-based E-field measurements with a field mill show an enhanced E-field in the vicinity of the apparatus in agreement with a simple electrostatic model of the wire.

Geodesy

G32-17A

The 1982-83 El Nino and the Earth Rotation

T. M. Eubanks
D. C. Pergquist
J. O. Dickey
J. A. Steppe (all at Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109
R. D. Rosen, D. A. Salstein, Atmospheric and Environmental Research, Inc, Cambridge, Massachusetts

The 1982-83 El Nino was characterized by wide spread changes in the atmospheric and oceanic circulation. The southern oscillation index, a measure of the intensity of the El Nino, reached record lows in January, 1983. The period between December, 1982, and March, 1983, is also associated with highly anomalous changes in the Length of Day (LOD) and the Atmospheric Angular Momentum (AAM). The AAM reached a record high in late January, 1983, which is matched by an unusual peak in the LOD at the same time. These changes were due to a weakening of tropical easterlies and a strengthening of the mid latitude westerlies, especially in the northern hemisphere. At least $3/10^{25}$ kg m^2 sec^{-1} of eastward angular momentum was absorbed and then lost by the atmosphere during the period from mid January to mid February, 1983. Changes in the atmospheric mass distribution do not seem to have contributed significantly to the January, 1983, AAM anomaly. An examination of LOD data from the previous strong El Nino in 1972 shows no unusual LOD changes. The relationship between the January, 1983, events and the seasonal cycle of Angular Momentum will be discussed.

Geomagnetism and Paleomagnetism

GP32-21 POSTER

CRUSTAL MAGNETIC ANOMALIES IN CANADA

J. ARKANI-HAMED, W.E.S. URQUHART, D.W. STRANGWAY, (Department of Geology, University of Toronto)

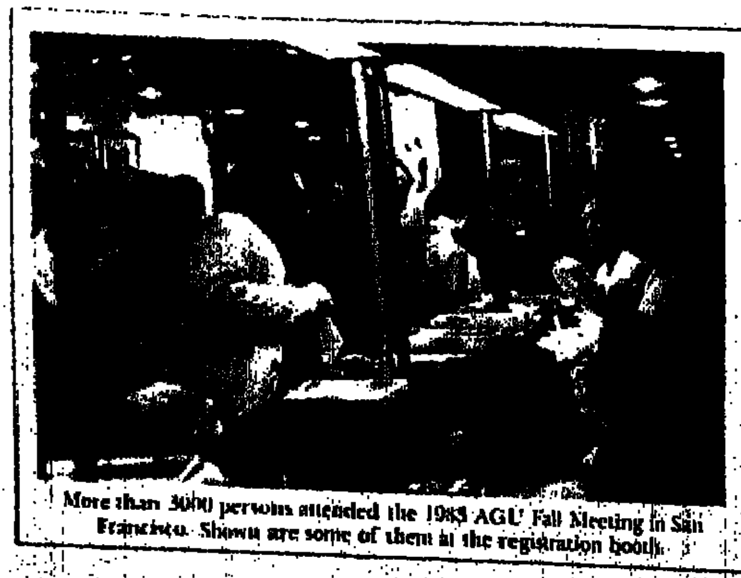
The crustal scalar magnetic anomaly map of Canada and the northern United States deduced from MAGSAT data is downward continued to 5 km altitude. The anomalies have no obvious correlation with tectonic provinces, but they do appear to correspond with certain types of sedimentary basins. Basins associated with old hot spots and intercontinental rifts have positive anomalies, whereas those in the centre of cratons have negative anomalies. Modern hot spots and mountain ranges also have negative magnetic anomalies.

GP51-11

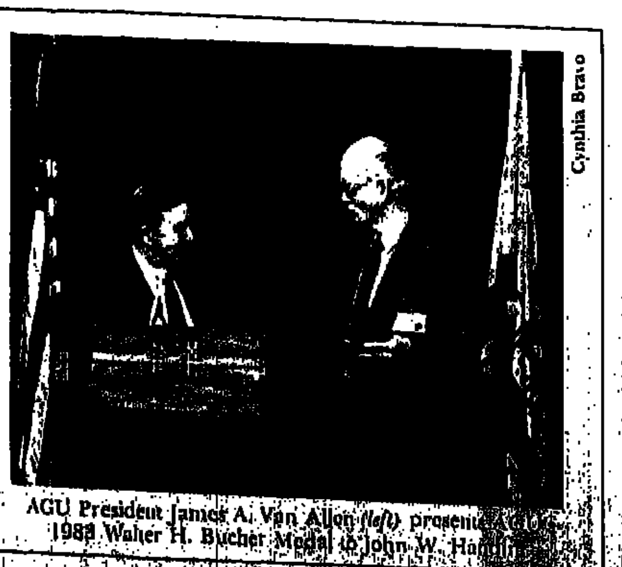
J.C. Gupta, R.D. Kurtz and P.A. Canfield (Division of Seismology and Geomagnetism) Earth Physics Branch, Ottawa, Canada, K1A 0Y3). (Sponsor: G.G.R. Buchbinder)

An Induction Anomaly on the West Coast of Hudson Bay

The geomagnetic data collected during the International Magnetospheric Study (IMS) interval between 1976–1980 at the Canadian Stations located along the Churchill array are used to compute the transfer functions to investigate the conductivity structure in the region. The transfer function arrows suggest that an east-west trending terrestrial conductor passes between Back and Gillam, Manitoba. The trends of surface geology then suggest the linkage of this conductor with the North American Central Plains conductor.



More than 3000 persons attended the 1983 AGU Fall Meeting in San Francisco. Shown are some of them at the registration booth.



Cynthia Bravo

AGU President James A. Van Allen (left) presents the 1983 Walter H. Bucher Medal to John M. Harr[illegible]

Hydrology

H22A-13 REVISION

Downstream Lateral Mixing of Waters from the Orinoco, Atabapo and Guaviare Rivers, in Southern Venezuela.

FRANZ H. WEIBEZAHN (Instituto de Recursos Naturales, Universidad Simon Bolivar, Caracas, D.F., Venezuela) (Sponsor: Carl F. Nordin)

The waters of the Orinoco, Atabapo and Guaviare rivers, at their coincident confluence at San Fernando, are markedly different in their chemical composition, as well as in their suspended sediment concentrations. According to Sioli's classification of South American river waters, they fit into the clear, black and white water rivers, respectively.

A quantitative study was undertaken to measure the lateral mixing of these waters, at their rising stage, June 15–19, 1983. Measurements were made at cross sections, one at each river mouth and 4 along the main stem of the Orinoco, downstream from the confluence. Samples were taken at 3 points on each of the 7 cross sections. Water, at each sampling location, was taken with an integrating bottle, from the surface to one meter above the bottom. Surface temperature, pH and conductivity were measured at the field sites, and alkalinity, NO_3-nitrogen, total dissolved phosphorus, dissolved organic carbon and suspended sediments (<62 and >62 um) concentrations were determined at the laboratory.

Discharge and geometry of the channel had a marked effect on the mixing rate of the 3 river waters. Transverse mixing was slow and the results of the measurements and analyses of suspended sediments, alkalinity, total dissolved phosphorus, NO_3-nitrogen, conductivity, dissolved organic carbon, pH and temperature (in a decreasing order of importance as indicators for differentiating the water masses) show that up until approximately 100 Km below their confluence, just above where the Vichada River comes in, the Orinoco, Atabapo and Guaviare waters had not yet fully mixed.

Ocean Sciences

O11A-12A

Reduced Trace Gases under Low Oxygen Conditions in the Water Column of Saanich Inlet, British Columbia

M. A. de Angelis, J. A. Baross, M. D. Lilley (all at College of Oceanography, Oregon State University, Corvallis, OR 97331)

The reduced gases H_2, CH_4, CO and N_2O, as well as O_2, NH_4OH, NO_2^-, NO_3^-, NH_4^+, ATP and denitrification potential (acetylene blockage technique) were measured throughout the water column of Saanich Inlet, British Columbia in October, 1982 and in February, April, August and September, 1983. Sampling was concentrated in the mid-water column where low O_2 (<20 nM) conditions prevailed. A high degree of variability in the reduced trace gas and nitrogen species concentrations was observed in this region and is believed to reflect outcible production/consumption mechanisms for these gases and nutrients. Correlations were observed among H_2 maxima (5.7 to 18.1 nM), high denitrification potentials (123 to 181 nmoles N_2O/l/day) and ATP maxima (202 to 489 pM). Additionally, the coincidence of H_2 and CO maxima (2.5 to 8.0 nM H_2; 6.1 to 27.0 nM CO) as well as H_2 and NH_4OH maxima (4.2 to 8.0 nM H_2; 3.6 to 65 nM NH_4OH) may be the result of consumption mechanisms involving CH_4 and NH_4 respectively. The data suggest that the mechanisms regulating the distributions of these gases and nitrogen nutrients in Saanich Inlet may be controlled by O_2 concentrations at low O_2 levels (0.2 to 20 nM O_2).

O12A-13A POSTER

The California Coastal Current Program

PLUTCHAK, NOEL B. and ROBERT J. TAIT (Raytheon [illegible] 5126 Ralston St. Ventura, CA. 90099)

Under the sponsorship of Bureau of Inter[illegible] Mineral Management Service, an extensive pro[illegible] of measurements in the coastal waters of cer[illegible] California (Point Conception to San Franc[illegible] area) is beginning in November 1983. measurement components are: 1) Time va[illegible] measurements of current speed and direct[illegible] pressure, temperature and conductivity at moo[illegible] sites selected to best capture the flow patt[illegible] indicated by the results of historical stud[illegible] These have characterized the large scale feat[illegible] of the region as a number of flow reg[illegible] approximately paralleling the trend of the co[illegible] 2) Near-synoptic hydrographic lines run rou[illegible] normal to the coast at intervals along the c[illegible] of 50 km and extending offshore to about 70 [illegible] 2a) Continuous current profiles along hydrographic tracks using a ship mounted dop[illegible] acoustic meter. 3) Near-synoptic aerial map of the surface (100 feet ASL) wind and tempera[illegible] fields and the surface radiant water tempera[illegible] over a limited geographic area in the vicinit[illegible] Point Conception during the hydrogra[illegible] measurments in that area. 4) Aerially me[illegible] Lagrangian motion along the hydrographic l[illegible] during the time of hydrograhpic work and als[illegible] the locations of pertinent small scale sur[illegible] motions shown to exist by satellite imagery.

Historical and ancilliary data from other sou[illegible] in the region will be collected into the data for guidance in the sampling design and comparison with the on-going results. particular winds from the coastal sites, one and offshore will be analyzed for their influ[illegible] on shifts in the current structure.

An advisory committee and workshops will convened to guide the program.

O21A-19

Influence of Hydrothermal Emissions on Environment in Santorini and Milos Islands (Cyclades, Greece)

J. N. VALETTE-SILVER (C.N.R.S.-Universite de Perpignan, 66000 France, and Carnegie Institution of Washington, U.S.A.)

The chemistry of five hot springs situated on islands from the Cyclades were studied. They are located on land or at sea, on the bottom of bays or fractures on Santorini-Nea Kameni (Sterna and Megalos), Milos (Theiorixoin and Havrogronna) and Kimolos (Thermopulra). The chemistry of the springs shows the strong participation of seawater in the hydrothermal fluid. Compared to standard sea water, Fe, Mn and SiO_2 are always in excess in the springs with Fe/Mn ratios varying from 5 to 10. At the interface between hydrothermal fluids and sea water, strong precipitation occurs. The new material formed is predominantly amorphous to cryptocrystalline and is composed of Fe and SiO_2 with Fe/Si ratios varying from 2 to 3. At sea, variations in the composition of seawater, rocks and sediments surrounding the mouth of the hot spring depend mostly on the pH and chemistry of the hydrothermal fluid. For example, on Milos in the Theiorixoin Hot Spring, the pH is very low (≤1.8) and the waters exhibit the highest concentrations of dissolved Fe and Mn of the five springs studied. The sediments surrounding the vents are also very rich in Mn, with the crystals observable on detrital grains. On the contrary in Santorini, where the pH of emission is higher than 5, Ca and B are frequently associated with Fe and SiO_2 in the water sediments.

On land, fumaroles and hot springs modify the surrounding material. For example, in comparison to the unaltered rocks, SiO_2 and K are always depleted, whereas metals such as Cu or Mn are often enriched.

O21A-20

HYDROGEOLOGIC STUDIES IN THE SOUTHWEST PACIFIC: PRELIMINARY RESULTS OF DSDP LEG 92

M. LEINEN, (Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882-1197)
D.K. REA (Department of Atmospheric and Oceanic Sciences, University of Michigan, Ann Arbor, MI 48109
LEG 92 SHIPBOARD SCIENTIFIC PARTY

Leg 92 completed multidisciplinary hydrogeologic studies of seven sites in the Pacific to examine the controls on past and present hydrothermal processes. Six new sites, Sites 597-602, were drilled in four areas which form an E-W transect on the west flank of the East Pacific Rise at 19°S. Basement ages of the four drilling areas were approximately 28.5 Ma, 17 Ma, 18.5 Ma, and 4.5 Ma. The sediments at those sites were dominantly nannofossil oozes with varying proportions of iron oxide-rich clay most of which is probably hydrothermal in origin. The base of each sediment section contains chalks which are not of hydrothermal origin. Pore waters showed no evidence of present-day hydrothermal advection through the sediments. The oldest site, 597, was re-entered and drilled 91m into basement with 53% recovery. The basalts were rodius to fine-grained ferrobasalts, dominantly massive flow units, and have undergone at least three stages of alteration.

Leg 92 also returned to Site 504B for a suite of downhole experiments including multi-channel sonic logging and a seismic experiment using a borehole seismometer as a receiver. Preliminary results suggest considerable anisotropy in fracture patterns around the hole. Downhole temperature logging showed that downhole flow forced by under pressure has decreased to 2-3 l/hr and that the bottom hole temperature is now about 160–165°C. Water sampling showed extensive reaction of borehole waters with either the basalts or the drilling mud in the hole.

O11-11A

Trace Gases in the Blanco Trough and on the Gorda Ridge

M. D. Lilley, J. A. Baross and L. I. Gordon (all at College of Oceanography, Oregon State University, Corvallis, OR 97331)

The Blanco Fracture Zone which connects the Juan de Fuca and Gorda Ridges is comprised of numerous troughs with the largest and deepest being the Blanco Trough (44° 20'N, 130° 0'W).

Vertical profiles of O_2, N-nutrients, CH_4, H_2 and N_2O were taken in the Blanco Trough in June, 1983. Compared to concentrations at similar depths at a station removed from the ridge-trough area (38°N, 145°W), O_2 was reduced by approximately one-half within the trough; CH_4 was a factor of two higher within the trough except very near bottom where it was undetectable. H_2 concentrations were similar at both stations. The reduced gases and nutrients all showed considerable vertical structure in near bottom samples within the trough.

A series of near bottom hydrocasts were also made during a general survey for hydrothermal activity on the Gorda Ridge in August, 1980. One of these stations (42° 06'N, 127° 09'W) exhibited CH_4 concentrations an order of magnitude above the ambient deep value in the lower 400 meters, indicating that the cast may have been in the vicinity of an active vent.

O42-02 REVISED

Argon 39! The first deep profile! (Continued....)

H. CRAIG, K. KIM (Scripps Institution of Oceanography, UCSD, La Jolla, CA 92093).
H.H. LOOSLI, U. WEIDMAN, P. KALT (University of Bern, CH-3012 Bern, Switzerland).

The first depth profile for ^{39}Ar (a cosmic-ray produced "non-transient" tracer, mean-life = 388 years = 5% of radiocarbon mean-life) was reported for surface, 250 m, and 600 m depths of the N. Pacific Geosecs 1 Station, two years ago (Craig, Kim, Loosli, Oeschger, EOS 62, 912, 1981). We now have data (also for ^{85}Kr) at depths of 0, 150, 250, 400, 600, and 4200 m (possibly more by AGU time!). Samples for each depth consist of 600 cc(STP) of Ar, stripped from 2 tons of ocean water; ultimately a 10 depth profile, representing 20 tons of water, will be completed. At 600 m the ^{39}Ar activity is 40% of "modern" (defined as atmospheric and surface water activity). At 4200 m depth we observe a ^{39}Ar activity = 17% of modern (the counting rate/sample here is 0.02% of that for radiocarbon measurements, which gives an idea of the effort involved). The ^{14}C "Mucry age" (exponential decay time) for this water is 1840 years, which gives a predicted ^{39}Ar activity = 4 ka of 0.9% modern (vs. 17% measured!). For a simple two-box mixing model, however, the radiocarbon data give a deep water residence time (at Geosecs 1) of 2175 years; in this model the predicted deep water ^{39}Ar activity is 15% of modern. Reasons for this, and other models will be discussed. ^{85}Kr will be compared in the upper waters; at 4000 m the activity is less than 0.1 dpm/ccKr, indicating no air contamination (< 0.5%) in the sample. Although the 250-kg-sample Gerard Barrels of GEOSECS fame no longer exist, we fortunately have two more Pacific profiles intact for measurement. The audience will be asked to rise and face toward Seattle for a moment's silent meditation at the close of this talk, in tribute to the late Gerard Barrels which have made that final deep cast! the longest one of all. Sic transit gloria maris!

O51B-14A

Modeling Storm-Driven Currents in the Santa Barbara Channel

R. B. Gordon (Exxon Production Research Co., Houston, TX 77001)

The response of the Santa Barbara Channel to storm winds was investigated using a two-dimensional (x-z), two-layer numerical model. The model has a surface mixed-layer that entrains according to a velocity dependent parameterization, and a lower layer in which the density varies linearly with depth.

The passage of a storm that occurred in February, 1959, was simulated in detail in order to illustrate the highly non-linear response resulting from large displacements of the thermocline and from the entrainment process. For this storm, estimates of the long-shore barotropic pressure gradient were available from calculations conducted at the University of California, Santa Barbara, using a three-dimensional model covering a large section of the California shelf surrounding the Channel.

In this simulation, it was necessary to increase the depth of the nearshore grid cells in order to prevent the thermocline from intersecting the bottom. The effect of this artificial deepening was estimated qualitatively by using Csanady's linear coastal jet theory for a channel with arbitrary depth variations.

Because the entrainment rate is such a highly nonlinear function of the mixed-layer depth and the velocity difference between layers, the sensitivity of the computed solution to uncertainties in the initial and forcing conditions and to grid resolution and horizontal eddy viscosity was investigated.

Seismology

S11B-37 POSTER

Seismic Recordings Containing Frequencies in the Audio Range

E. CRANSWICK (U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025)

Frequencies as high as 100 Hz are present in the seismograms of recent aftershocks of the January 9, 1982 Miramichi, New Brunswick earthquake. Both sources and receivers of these seismograms recorded in July 1983 are located within the boundary of a granitic pluton that underlies the aftershock zone. This high frequency phenomenon was observed at ranges of less than 10 km at six different stations all of which were equipped with three-component 2 Hz velocity transducers sited directly on basement outcrop and recorded by GEOS digital seismographs sampling each component at 400 sps. Some records show resonances at about 60 Hz and 100 Hz on the vertical and horizontal components respectively. These high frequencies are absent in records made with identical instrumentation at a site at which the transducer was separated from the basement rock by roughly ten meters of low velocity surface sediments. A smaller data set of three-component digital records sampled at 1200 sps per channel recorded at a seventh hard-rock site shows a high frequency limit at about 100 Hz.

The presence of these high frequencies indicates that the exposed crystalline rocks are characterized by low anelastic attenuation. This observation is in accord with the reports of sounds associated with earthquakes in northeastern North America. Furthermore, the difference between the resonant frequency of the vertical components and that of the horizontal components suggests that seismic waves at these high frequencies interact with some small scale (tens of meters) structures such as exfoliation joints within the outcrop.

S12B-15A

Evidence for Lowermost Mantle Heterogeneity from LASA

C. A. Powell (Department of Geology, UNC-Chapel Hill, Chapel Hill, N.C. 27514)

Array determined azimuth of approach, ... values for teleseismic events occurring at distances exceeding 90° agree favorably with values predicted by the new model for lower mantle heterogeneity determined by Dziewonski (1983). Agreement was noted for two large arrays located in the western U.S., LASA and Hanford. Predicted ζ anomalies calculated using the Dziewonski model agree in sign and relative magnitude with ζ anomalies calculated for LASA for nine out of ten globally distributed ray paths. LASA ζ anomalies are always larger in absolute magnitude but this is to be expected as the Dziewonski model produces a low pass filtered view of the velocity perturbations. Disagreement is greatest for ray paths originating in southern Russia. Additional near array lower mantle structure is needed to explain the LASA and Hanford ζ anomalies associated with this source region. The overall excellent agreement between LASA and predicted anomalies suggests that additional, unambiguous information concerning lower mantle heterogeneity can be derived from the LASA array diagram.

SPR: Aeronomy

[illegible]

Observations of an Ionospheric [illegible] from the Coalinga Earthquake of 2 May 1983

J. H. Wolcott (Atmospheric Sciences Group, Earth and Space Sciences Division, Los Alamos National Laboratory, [illegible])
D. J. Simons (Atmospheric Sciences Group, Earth and Space Sciences Division, Los Alamos National Laboratory, Los Alamos, NM 87545)
C. D. Lee (SRI International, Menlo Park, CA 94025)
R. A. Nelson (SRI International, Menlo Park, CA 94025)

At 23:42:38.5 UMT on 2 May, 1983, a moderate earthquake occurred approximately 13 km northeast of Coalinga, California. The Rayleigh wave generated by this earthquake coupled enough energy into the atmosphere to generate a pressure pulse that created a large scale traveling ionospheric disturbance. This disturbance was detected by an ionospheric monitoring network at five locations that were separated from the earthquake epicenter by between 160 and 265 km. These observations are the first ionospheric disturbances to be reported this close to an earthquake epicenter.

SPR: Cosmic Rays

[illegible]

Observations of the E-W Asymmetry of Solar Flare ESP Events by the IMP-7 and 8 s/c.

P.C. TRICHTUTSOS, E.T. SARRIS, G.C. ANAGNOSTOPOULOS (Democritos Univ. of Thrace, Xanthi, Greece)
S.M. KRIMIGIS (APL/JHU, Laurel, MD)

Observations of energetic-ion intensity enhancements (E > 290 keV) associated with solar flare generated shock waves (solar flare ESP events), obtained during nearly a decade by the APL/JHU instruments on board the Earth orbiters IMP-7 and 8, are incorporated in this work in order to examine the role of the large scale shock morphology with relation to the upstream interplanetary magnetic field in the formation of these ESP events. It is shown that a clear East-West solar hemisphere asymmetry is present in the distribution of the ESP relative intensity enhancements with respect to the heliolongitudes of the shock wave source-flare sites. The large ion-intensity enhancements superimposed on the ambient solar flare ion population are preferentially associated with solar flare sites located to the East of the spacecraft Meridian, whereas on the average only weak ESP events are associated with solar flare sites to the West of the spacecraft Meridian. The observed asymmetry and its implication on the dominant processes for the generation of the solar flare ESP events are discussed on the basis of the presented extensive survey.

SPR: Magnetospheric Physics

SM11B-08A

Implications of Steady State Particle Entry for the AMPTE Program

V. P. OLSON (McDonnell Douglas Astronautics Company, Huntington Beach, CA 92647
K. A. PFITZER (McDonnell Douglas Astronautics Company, Huntington Beach, CA 92647)

Studies using realistic magnetic field models have shown that KeV particles can enter the magnetosphere even when it is magnetically closed. This form of charged particle entry proceeds at all times and influences many steady state magnetospheric processes. This entry mechanism is present because when magnetosheath particles impact the magnetosphere, they encounter a gradient in the magnetic field parallel to the magnetopause. Their subsequent motion in such a structured magnetic field allows some of them to permanently enter the magnetosphere. Because of the symmetry of the magnetospheric magnetic field, the flux of entering particles is zero along the noon-midnight meridian plane. The entry flux is largest near the equator along the flanks of the magnetopause and also occurs in the dayside cusp regions.

This entry model suggests that the AMPTE release near the subsolar point will place the tracer ions near the region of minimum entry. As the ions move through the shock and are dispersed down the dawn flank of the magnetosphere, the entry rate will increase. The motion of the ions after entry will depend on both magnetic and electric field structures. It is expected that the most likely path [illegible] for the ions after entry will [illegible] drift [illegible] the near tail region [illegible] field lines into the polar [illegible] sphere. The [illegible] drift along the tail may [illegible] all the way around the earth. [illegible] spacecraft [illegible] after their release.

[illegible]

Transport [illegible] of [illegible] Ions through the Earth's Magnetosphere

L. C. Lee and [illegible] (Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701)

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

A model of the transfer in a partially open magnetosphere is presented which begins with the localized and sporadic merging of magnetosheath and magnetospheric field lines to form bundles of field lines or FTE's, with magnetic field and plasma properties [illegible] field lines. [illegible] of the FTE's, which [illegible] the magnetic field within them [illegible] that in the magnetotail [illegible].

[illegible] the magnetosphere portion of the FTE. This is [illegible] self-similar expansion of a plasma into a vacuum. The extent of both the plasma depletion in the magnetosheath portion and the plasma filling in the magnetosphere portion are a function of time or distance down the magnetotail. The radial extent of the drained portion of the FTE from the center of the magnetotail also increases with distance down the magnetotail, to about [illegible] R_E at [illegible] R_E.

The model explains both observed temporal changes in magnetotail boundary layer thickness and "[illegible]" as a function of IMF B_z. It also provides the simplest explanation for the boundary normal variations [illegible] boundary [illegible] observations [illegible] magnetopause, and correlation between boundary [illegible] and both the AE index and southward IMF B_z.

SM42A-11 POSTER

Numerical Simulation of the Tearing-Mode Instability in an Anisotropic Neutral Sheet

J. J. Ambrosiano (Berkeley Scholars, Inc., P.O. Box 852 Springfield, Virginia, 22150)
L. C. Lee and Z. F. Fu (Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701)

A systematic study, utilizing a magnetoinductive particle simulation, is performed to evaluate the tearing-mode stability properties of a field-reversed plasma layer with an anisotropic temperature distribution ($T_\parallel \neq T_\perp$). Distributions with $T_\perp > T_\parallel$ are shown to greatly enhance the linear growth of the instability, while those with $T_\parallel < T_\perp$ are strongly stabilized. The simulation results are consistent with the results of Laval and Pellat[1] based on the energy principle, and the recent linear analysis of Chen and Palmadesso[2]. A surprisingly small amount of anisotropy evidently produces a large effect. The nonlinear phase of the simulations is influenced by a variety of conditions including the length and width of the simulated region; however, the conversion from magnetic to kinetic energy is in each case enhanced by a $T_\perp > T_\parallel$ anisotropy.

1. G. Laval and R. Pellat, ESRO SP-36,5 (1969).

2. J. Chen and P. Palmadesso, "Tearing Instabilities of an Anisotropic Neutral Sheet", submitted to Phys. Fluids (1983).

Tectonophysics

T32A-01 REVISION

Ultrasonic Measurements of V_p and Q_p^{-1} on an Alkalic Basaltic Melt: Indirect Deduction of Viscosity Values

Meetings (cont. on p. 58)

Meetings (cont. from p. 57)

[illegible]

Volcanology, Petrology, and Geochemistry

[illegible]

VIZA-14A

Depositional ramps of the Ata pyroclastic flow deposit in southwestern Japan

K. SUZUKI and T. UI (Department of Earth Sciences, Faculty of Science, Kobe University, Nada, Kobe 657 Japan)

The Ata pyroclastic flow deposit is one of large-scale pyroclastic flow deposits erupted 30,000 - 60,000 years ago. The eruption was started with small-scale plinian air fall, local minor pyroclastic flow and succeeded by the climax eruption of the Ata pyroclastic flow. The deposit is densely welded, even in case of a thin deposit. The deposit shows a asymmetrical distribution within a valley channel or a basin. Such a structure was named depositional ramps (1) and recognized in a wide valley or basin whose width is more than 1 km. Height difference between the highest and the lowest points of a single depositional ramps is larger in wider valley. Ramping directions show the radial directions away from the source. Scale of depositional ramps decreases with increase of distance from the source. This structure is regarded to be formed by the excellent accumulation of pyroclastic materials in a windward-side rather than a lee-side within a valley or basin. Dip angle of the original surface is assumed within 4°, which is similar to the repose angle of large-scale pyroclastic flow deposit previously described. The same structures were also recognized in other two densely welded pyroclastic flow deposits based on published geologic map and topographic map. But this structure is difficult to find in a non-welded pyroclastic flow deposit. This suggests that high emplacement temperature is helpful to form depositional ramps.

(1) Suzuki, K. and Ui, T. (1982) Geology, 10, 429-432.

V32A-20 [illegible]

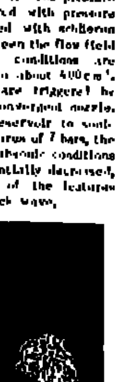
Chemical and Isotopic Composition of Casa Diablo Hot Spring: Magmatic CO_2 Near Mammoth Lakes, CA

B. E. TAYLOR (Department of Geology, University of California, Davis, CA 95616)
T. M. GERLACH (Sandia National Laboratories, Albuquerque, NM 87185)

Combined chemical and isotopic analysis of fumarolic gases collected at the Casa Diablo Hot Springs (boiling; 95-97°C) near Mammoth Lakes, CA, indicate that magmatic CO_2 is presently reaching the surface here. Fifteen vapor-phase samples were collected in 11/82, 1/83, and 4/83 using a thermally insulated tube inserted a meter into the fumarole, and evacuated sampling vessels containing alkaline solutions. This technique precluded condensation and direct atmospheric contamination during sampling, the latter indicated by low levels of N_2 (< 0.003 mole %) and O_2 + Ar (< 0.75 molar ppm). Complete chemical analysis of the samples yielded an average composition (in mole %) of 99.4 H_2O, 0.5 CO_2, and 0.01 to 0.04 total S (mainly and H_2S); HCl, HF, CO and hydrocarbons other than CH_4 were below detection limits. H_2 and CH_4 did not exceed molar ppm levels.

Carbon isotope analysis of separated CO_2 indicated $\delta^{13}C$ values of -5.59 and -5.68 ‰. These δ-values are within the range of compositions [illegible] ... paucity of limestone in the subsurface, excludes non-magmatic sources as the principal origin for the CO_2.

These data suggest: (1) CO_2 is exsolving from magma beneath Casa Diablo, and (2) monitoring the relative CO_2/H_2O ratio of the fumarolic gases might prove useful to evaluate subsurface movements of magma.



[illegible]

Fig. 1. [illegible]

Assessing Nuclear Explosions

The all-Union session on the Geophysical and Geochemical Consequences of Nuclear Explosions at the 1983 AGU Fall Meeting attracted a large audience, and many were unable to find a seat or standing room. The speakers and questioners emphasized the complexity of the processes and the need to extend the computer models. In particular, the global-circulation models presented by scientists from the National Center for Atmospheric Research showed that smoke/dust clouds should cause major changes in the weather systems with great contrast between the temperature perturbations over oceanic, coastal, and continental regions. Important developments in the models and conclusions can be expected over the next few years as AGU members from many disciplines contribute their skills. On behalf of the Public Affairs Committee, I want to thank all the speakers at San Francisco for their excellent presentation on a difficult subject.

This meeting report was prepared by Joseph V. Smith, *who is with the Department of the Geophysical Sciences, University of Chicago, Chicago, IL 60637.*

Latin American Geomagnetism Workshop

Modelers of the earth's magnetic field look to the network of magnetic observatories to provide information on secular change. Others, studying the shorter period variations, want the observatories to provide digital, machine-readable data. Whatever the application, whether it be the data base for the International Geomagnetic Reference Field, time extrapolation for satellite surveys, or magnetospheric current studies, all users want more from the observatories than is presently available, especially from that part of the world composed largely of developing countries. Money might solve some of the problem, but it is generally unavailable. However, there are other factors, some of which are more amenable to solution.

In an attempt to improve the data base, there has been proposed a series of regional workshops, bringing together the operations people and the users to discuss problems and solutions. The first of these was the Workshop on Latin American Geomagnetic Observatory and Survey Practice held at the Observatório Nacional in Rio de Janeiro, October 16–22, 1983. There were 45 participants from 15 countries of Latin America, North America, and Europe. The stated objective was to improve the quality of the Latin American geomagnetic programs by informing the participants of the state of the art in the various areas of geomagnetic work; discussing common problems and their solutions; promoting information exchange by personal contact among the participants; providing information which might assist in strengthening the bases of national programs; and encouraging participation in international programs.

The following topics were covered: observatory operations, field surveys, magnetic instruments, field modeling, magnetic cartography, uses of magnetic data, and national and international programs. There were formal papers and round tables; papers were delivered bilingually, in English and Spanish or Portuguese. Several important needs became apparent during the proceedings. These were put in the form of resolutions, including the encouragement of geomagnetic research on regional phemomena; periodic checks of observatory standards against the International Magnetic Standard; the desirability of digital recording; improvement in opportunities for training and exchange of personnel and information; and closer collaboration with IAGA and the World Data centers.

Positive steps were taken by participants toward establishing new observatories in some of the data gap areas. All agreed it would be appropriate to have another workshop in 5–10 years.

This workshop was sponsored jointly by the Sociedade Brasileira de Geofísica, the Observatório Nacional, the Pan American Institute of Geography and History, the Inter American Geodetic Survey, the Instituto Geofísico del Perú, World Data Center "A" in Boulder, Colo., and the International Association of Geomagnetism and Aeronomy. Co-organizers were J. S. Lourenço of the Brazilian society, L. M. Barreto of the Observatório Nacional, M. Casaverde of the Peruvian institute, and K. L. Svendsen, representing World Data Center "A".

The Observatório Nacional is planning to publish transactions of the workshop. Papers will be in the language of original presentation and abstracts will be available in at least English and Spanish. Distribution will be to the attendees, to those Latin Americans who were invited but could not attend, and to magnetic observatory operators throughout the world. Inquiries may be directed to L. M. Barreto, Director, Observatório Nacional, Rua General Bruce No. 586, São Cristóvão, 20921 Rio de Janeiro, Brazil.

This meeting report was contributed by K.L. Svendsen, *who is with World Data Center A, Boulder, CO 80303.*

Actions at Hamburg

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UNESCO/IASPEI Working Group on a Code of Practice for Earthquake Prediction

In recent years, a number of earthquake predictions have been made, both by individual scientists and by institutions, some of which have proved successful and have been followed by action which has resulted in the saving of human life and the reduction of material losses. Others have been unsuccessful but their publication has led to serious disruption of economic and social activity in the areas affected by the predictions.

The successful prediction of earthquakes is an important scientific objective, and research in this field should be actively encouraged, but it is clear that scientists who are engaged in such research, and who find themselves in a position to make predictions, must bear an unusual degree of social responsibility.

Ill-considered release of a prediction to the public domain may have grave social consequences; on the other hand, a successful prediction may be instrumental in saving many lives but only if it leads to appropriate and well-organized response by the community concerned.

Following an agreement reached between UNESCO and IASPEI, a Working Group on a Code of Practice for Earthquake Prediction met in Hamburg August 12–13, 1983. A list of the participants appears at the end of this report.

Given the wide variety of social structures within which research on earthquake prediction is conducted in various countries, the task of defining a Code of Practice having universal validity is one which will require wider study. In drafting this code, however, the meeting regarded its task not as one of defining a code of ethics, but rather of recommending guidelines for the more effective formulation, evaluation and communication of earthquake predictions for the benefit of society.

Code of Practice for Earthquake Prediction

The objectives of this code of practice are as follows:

1. To ensure that scientific earthquake predictions are put forth in such a way as to **favor constructive social response.**

2. To **encourage seismologists to undertake research** in the broad field relevant to seismogenesis and earthquake prediction.

3. To **assist the development of earthquake prediction** as a means both of testing hypotheses of seismogenesis and of mitigating earthquake risk.

4. To prevent scientific predictions being confused in the public mind with predictions not based on **scientific observation and reasoning.**

5. To **promote international cooperation and goodwill** in the area of earthquake prediction.

Formulation of Predictions

Considering that research of earthquake precursors is now progressing from the stage of data collection towards the stage of hypothesis-testing, **it is recommended that predictions be formulated in terms of probability,** i.e., the expectation, in the space-time-magnitude domain, of the occurrence of an earthquake. The strength of the predictive statement is then represented by the increase in the expectation, compared with that prevailing before the prediction was made.

As a prediction develops in the course of continuous monitoring of the region, the expectation may be progressively modified on the basis of further precursory data or other relevant occurrences, so that the prediction process itself becomes continuous. Likewise the performance of the hypothesis can be continuously reassessed. The region being monitored will in general include areas of reduced expectation as well as areas of increased expectation, and the prediction as a whole can, if appropriate, be readily adopted as a basis for designing or modifying earthquake countermeasures in the region.

Scientific Evaluation of Predictions

Earthquake **predictions need to have adequate support from within the seismological community** before being considered acceptable as a basis for the formulation of warnings. Scientists should therefore seek to have predictions confidentially reviewed by their scientific colleagues and should ensure that such support is forthcoming before making them more widely known.

In countries where organizations have been set up or designated for the purpose of the scientific evaluation of predictions, scientists who wish to put forward predictions should submit them to the relevant organization.

Scientific editors who are considering the publication of papers containing earthquake predictions should take special precautions to ensure that adequate support from within the seismological community has been obtained for these predictions.

Communication to the Public and Public Authorities

Experience has shown that disorganized and counterproductive public response may arise from the direct communication of an earthquake prediction to the news media. **The news media are generally not the appropriate means by which to announce a prediction.** The author of a prediction should instead communicate the prediction confidentially to the governmental authority designated or best able to deal with such predictions.

At all times, scientists should exercise extreme care and restraint in communicating directly with the news media since the matter potentially affects the safety and socioeconomic stability of the population in the designated area.

Predictions Concerning Foreign Countries

Recognizing the serious problems that may arise from the prediction by scientists in one country of an earthquake that may affect another country, it is recommended that:

1. Originating scientists and scientific editors should give **careful consideration to the potential social and political effects** of a prediction concerning a foreign country.

2. Every effort should be made to **involve scientists of the affected country or region** cooperatively in the prediction effort and in the evaluation of specific predictions.

3. Appropriate scientists and governmental officials of **the affected country should be advised of the prediction effort at the earliest opportunity,** should be kept informed of the continuing research, and should be notified of the results sufficiently in advance of their public release to allow for response by the affected government.

Recommendations for Further Action

1. Considering that not all countries have earthquake prediction evaluation bodies, it is recommended that UNESCO, in collaboration with IASPEI, **establish an international earthquake prediction evaluation panel** or roster of experts which, upon request, will be available to assist any country in the evaluation of earthquake predictions.

2. Recognizing that scientists in one country may need to communicate predictions to appropriate authorities in another country, it is recommended that UNESCO request each member **state to designate an authority to receive earthquake predictions** emanating from other countries and to take any appropriate action.

3. Recognizing the importance of objectivity, reproducibility, and reliability of predictions it is recommended that UNESCO and IASPEI be requested to convene **workshops on algorithms** for earthquake prediction and evaluation.

4. Recognizing the importance of recent applications of **probability theory and exploratory data analysis** to the formulation and evaluation of earthquake predictions, it is recommended that UNESCO and IASPEI be requested to convene an **international meeting** on this subject.

5. Since earthquake predictions will be effective in reducing human and material losses only if they are followed by appropriate concerted action to reduce vulnerability in the affected areas, it is recommended that UNESCO and UNDRO undertake a detailed **study of the problems arising in the response** to long, medium, and short term earthquake predictions by civil defense and other relevant organizations.

Meeting Participants

C. R. Allen (USA); F. F. Evison (New Zealand); F. M. Fournier d'Albe (France); A. Giesecke M. (Peru); V. I. Keilis-Borok (USSR); C. Lomnitz (Mexico); G. Mader (USA); T. Rikitake (Japan); Xu Shao Xie (China). *For UNESCO:* M. Hashizume (France).

Announcements

Women Engineers and Scientists

The Baltimore-Washington section of the Society of Women Engineers will host the 1984 International Conference of Women Engineers and Scientists in Washington, D.C., June 17–24, with women from more than 30 countries expected to attend and participate in technical and professional seminars.

The theme for the conference will be "Technology—An International Bridge." Among the topics will be transportation, education, agriculture, computers, communications, energy, and medicine. Professional development sessions will also be held, focusing on the problems facing women in technical fields, the fulfillment of career goals through continued education, and management versus technical careers. For more information, contact Rosemary Markle, 9122 Battle St., Manassas, VA 22110; telephone 703-642-6035.

Groundwater Quality

The Second International Conference on Groundwater Quality Research, sponsored by the National Center for Groundwater Research and the U.S. Environmental Protection Agency, is scheduled for March 27–29 in Tulsa, Okla. The emphasis of the conference will be on the physical, chemical, and biological processes that control the movement and fate of contaminants in the subsurface. Papers have already been selected on topics including investigative methodology, biological and nonbiological transformations, sorption, and transport processes.

Early registration for the conference closes March 1. For further information, contact Norman Durham or Ann Redells, University Center for Water Research, Oklahoma State University, 203 Whitehurst, Stillwater, OK 74078, telephone 405-624-6995.

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Electromagnetics

0720 Electromagnetic Theory
NON-SPECTRAL REPRESENTATION FOR THE FIELD OF A HORIZONTAL WIRE ABOVE GROUND
M.P. Carpentier (Centro de Análise e Processamento de Sinais, Complexo Interdisciplinar, Instituto Superior Técnico, Av. Rovisco Pais, 1096 Lisboa Codex, Portugal), A.F. dos Santos

A representation in error functions for the current and field of a horizontal wire above ground excited by a delta function voltage generator is studied. This representation involves contributions from both proper and improper solutions of the modal equation and makes it possible to assess the relative importance of proper and improper solutions in the radiation mechanism. The new representation requires the analytic continuation of the field transforms into the whole complex plane of the transverse wave number which is studied for the first time as far as the improper half-plane is concerned. An asymptotic expression for the radiation field is obtained and it is shown that the principal improper mode provides a good approximation to the far field.

Rad. Sci., Paper 450186

0720 Electromagnetic Theory
THE FRECHET DERIVATIVES OF ELECTROMAGNETIC INDUCTION
Alan D. Chave (Institute of Geophysics and Planetary Physics, University of California at San Diego, La Jolla CA 92093)

The Fréchet derivatives of the fundamental toroidal and poloidal magnetic modes of electromagnetic induction are examined in detail. [illegible]

[illegible]

0799 General Electromagnetics
A DETAILED [illegible] OF THE JEMEZ VOLCANIC ZONE, NEW MEXICO
Mark E. [illegible] Laboratory [illegible] David W. [illegible]

The Jemez [illegible]

J. Geophys. Res., [illegible]

Exploration Geophysics

0920 Exploration Geophysics (Magnetic and electrical methods)
GROUND MAGNETIC SURVEY IN THE COSO RANGE, CALIFORNIA
Glenn R. [illegible] Center, [illegible]

[illegible]

0930 Seismic methods
SOUND SPEED AND ATTENUATION MEASUREMENTS IN GASSY SEDIMENTS IN THE GULF OF MEXICO
[illegible]

Geophysics, Vol. 49, No. 3

0930 Seismic Methods
THE NATURE OF SEISMIC REFLECTIONS FROM DEEP CRUSTAL FAULT ZONES
Terry D. Jones and Amos Nur (Rock Physics Project, Department of Geophysics, Stanford University, Stanford, California 94305)

[illegible]

Geophysics, Vol. 49, No. 3

0930 Seismic methods
THE MIGRATION OF COMMON MIDPOINT SLANT STACKS
[illegible] Stanford University, Stanford, CA 94305

[illegible]

0930 Seismic methods
TRAVELTIME INVERSION OF OFFSET VERTICAL SEISMIC PROFILES—A FEASIBILITY STUDY
[illegible]

essential whenever the ratio of source offset to layer depth becomes small. Traveltime inversion also requires careful estimation of layer velocities and proper statics corrections. Aside from these difficulties and the ubiquitous nonuniqueness problem, the VSP traveltime inversion was able to produce a valid earth model for tests on a real data case.
GEOPHYSICS, VOL. 49, NO. 1

Geochemistry

1610 Chemistry of the Atmosphere
BAYESIAN PROBABILITY CALCULATIONS FOR STRATOSPHERIC OZONE MODIFICATIONS
Lane Bishop (Allied Corporation, 20 Peabody St., Buffalo, NY 14210) and William J. Hill

A methodology is described for combining current information on ozone pertubations estimated from chemical model calculations and ozone trend analysis. This approach, known as Bayes analysis, yields probabilities for different amounts of change in total column ozone and ozone in Umkehr layer 8 (near 40 km). An examination is made of the sensitivity of the results to two different chemical models, and uncertainties involved in chemical model and trend analysis estimates. (Ozone trend analysis, ozone chemical model calculations).
J. Geophys. Res., D, Paper 4C0495

1610 Chemistry of the atmosphere
PHOTODISSOCIATION RATE OF MOLECULAR OXYGEN IN THE TERRESTRIAL ATMOSPHERE: SIMPLIFIED NUMERICAL RELATIONS FOR THE SPECTRAL RANGE OF THE SCHUMANN-RUNGE BANDS
Marcel Nicolet (Ionosphere Research Laboratory, The Pennsylvania State University, University Park, PA 16802 USA)

A numerical method is presented for modeling the photodissociation of molecular oxygen in the spectral range 175-200 nm of the Schumann-Runge bands [illegible] in the terrestrial atmosphere. It is possible to obtain realistic photodissociation rates that are in good agreement with detailed and complete calculations by using the following simple formulae [illegible] [illegible]

[illegible]

isotopic tracer to geological processes. Owing to the low abundances of ^{138}La and ^{138}Ce in nature, our measurements of $^{138}Ce/^{142}Ce$ ratios of natural samples have relatively large (>0.02%) errors, and the variations in Ce-isotope ratios were barely resolved. A tenuous anticorrelation was observed between ϵ_{Ce} and ϵ_{Nd} for terrestrial basalts and granites, indicating that with some improvement in analytical techniques the Ce isotopic composition may prove useful as a tracer for geological processes. A very low ϵ_{Ce} predicted from the Ce anomaly in the REE pattern of the Khohar L3 chondrite (Nakamura and Masuda, 1973) was not observed in this study, indicating that the Ce anomaly may be caused by terrestrial contamination or alteration. A low ϵ_{Ce} estimated for the source of Nakhla is consistent with our previous estimate (Nakamura et al., 1982) of a LREE depleted source. (Ce isotopes, La-Ce, Ce anomaly, meteorites).
J. Geophys. Res., B, Paper 3B5026

1499 Miscellaneous (Io's Surface)
EROSION AND MODIFICATION OF SO_2 ICE BY ION BOMBARDMENT OF THE SURFACE OF Io.
R.E. Johnson, J.W. Garrett, J.W. Boring, L.A. Barton (Engineering Physics, University of Virginia, Charlottesville, Va. 22901), W.L. Brown (Bell Labs, Murray Hill, N.J. 07974)

We report measurements of total yields, energy spectra and mass spectra of molecules sputtered from SO_2 ice at low temperatures by keV Ar^+ ions. These measurements are applicable to corotating sulfur and oxygen ion sputtering of SO_2 on Io. We find that the yields are much larger than those estimated earlier for low energy ion sputtering of SO_2 and the energy spectra are peaked at lower energies than expected. We observed the irradiation time dependence of the chemical alteration of fresh SO_2 leading to the production of new molecular species and identify masses 32 (O_2 or S), 48 (SO), and 80 (SO_3 or S_2O) as ejected species in addition to SO_2. These measurements are used to determine the rate of direct sputter ejection of sulfur into the Jovian plasma torus, the rate of erosion of patches of SO_2 ice, and estimates of the surface column densities of SO_3 in SO_2 ice produced by the corotating and fast ions. We estimate that the direct sputter ejection rate of sulfur to the Jovian plasma is of the order of 10^{10} atoms/cm^2/sec, that the erosion rate of fresh SO_2 deposits due to sputtering is of the order of 10^{-3} cm/year, and that only for penetrating ion bombardment can a significant, and possibly observable, column density of SO_3 be produced in an SO_2 frost.
J. Geophys. Res., B, Paper 3B5121

Geomagnetism and Paleomagnetism

2530 General (Ophiolite Magnetic Properties)
MAGNETIC PROPERTIES OF THE BAY OF ISLANDS OPHIOLITE SUITE AND IMPLICATIONS FOR THE MAGNETIZATION OF OCEANIC CRUST
B. Ann Swift (U.S. Geological Survey, Woods Hole, MA, 02543), H. Paul Johnson

Rock magnetic properties, opaque mineralogy, and degree of metamorphism were determined for 101 unoriented samples from the North Arm and Blow-Me-Down massifs of the Bay of Islands ophiolite complex, Newfoundland. The weathered and metamorphosed extrusive basalt samples have a weak, secondary magnetization arising from oxidation and exsolution of ilmenite of uranium origin. The initial magnetization of the underlying sheeted dike complex appears to have been destroyed by hydrothermal alteration soon after formation. The magnetic intensity of the gabbroic samples [illegible]

[illegible]

Geomagnetism and Aeronomy
Volume 23, Number 1

Brief informations

Letters to the editorial board

Chronicle

[illegible]

Hydrology

3119 Erosion and sedimentation
[illegible]

3125 Glaciology
[illegible]

3130 Groundwater
[illegible]

3130 Groundwater
[illegible]

3140 Limnology
[illegible]

3170 Snow and Ice
INSOLATION TOPOCLIMATES AND POTENTIAL ABLATION IN ALPINE SNOW ACCUMULATION BASINS: FRONT RANGE, COLORADO
C. A. Olyphant (Geology Department, Indiana University, Bloomington, Indiana, 47405)

Radiation data from the Institute of Arctic and Alpine Research, high altitude climatological station are used as input to a numerical model for computing insolation to rugged terrain. Simulated insolation topoclimates for an average (partly cloudy) summer day differ markedly from those that occur on a (rare) clear summer day. On a clear day, insolation is greatest in south facing basins and least in basins that face north. But on a partly cloudy day, east facing basins receive the largest daily insolation totals while north and south facing basins receive statistically equivalent amounts. An analysis of the correlation between radiation melt equivalent and measured glacier ablation suggests that computations of radiation melt should be based upon average diurnal trajectories of solar transmission if reasonable estimates of potential basin melt are to be achieved for alpine areas. (cirque insolation, glacier ablation, computer simulation).
Water Resour. Res., Paper 4W0022

3170 Snow and Ice
AN OVERVIEW OF PASSIVE MICROWAVE SNOW RESEARCH AND RESULTS
J. L. Foster (Hydrological Sciences Branch, Code 924, Goddard Space Flight Center, Greenbelt, Maryland, 20771), D. K. Hall, A. T. C. Chang and A. Rango

The current state of knowledge of the microwave properties of snow is discussed. Theory behind the microwave emission from snow is reviewed as are the physical processes of snowpack metamorphism. Field, aircraft and satellite passive microwave data have been acquired and analyzed for more than 10 years. Results have repeatedly demonstrated the feasibility of employing multifrequency passive microwave data to study snow-covered area, snow depth and internal snowpack properties. Radiation emanating from the ground beneath a snowpack is scattered by the snow crystals and concurrently the snow itself emits radiation at microwave frequencies. Thus, the radiation emerging from the snowpack is the result of a complex series of interactions both within and beneath the snowpack. Future studies recommended by a snowpack properties working group consisting of government and university scientists are discussed in detail. Recommendations include performing extensive laboratory measurements using real and artificial snow to be coordinated with theoretical modeling and aircraft overflights carrying passive microwave instrumentation. This is considered necessary in order to help to interpret the microwave responses to snow. (Passive microwave, snowpack, remote sensing).
Rev. Geophys. Space Phys., Paper 4R0095

3175 Soil Moisture
THE OPERATIONAL SIGNIFICANCE OF THE CONTINUUM HYPOTHESIS IN THE THEORY OF WATER MOVEMENT THROUGH SOILS AND AQUIFERS
Philippe Baveye (Department of Soil and Environmental Sciences, University of California, Riverside, California, 92521) and Garrison Sposito

The operational meaning of the Representative Elementary Volume (REV) concept, on which current foundational theories of water movement through porous media are based, is analyzed critically. It is concluded that the REV concept as applied to real porous media is both unnecessarily restrictive and experimentally unverifiable. In its place, a relativist concept is proposed in which macroscopic physical [illegible] extends theoretical validity in principle to all local measurements made on porous media. It is sufficient mathematically to derive conventional macroscopic balance equations for mass and linear momentum, as well as a differential equation for the isothermal transport of water through an unsaturated, anisotropic, deformable soil or aquifer. (Groundwater flow, soil-water equilibria, soil water movement, spatial variability).
Water Resour. Res., Paper 3W1992

Meteorology

3710 Boundary layer structures and processes
TRANSPORT OF OZONE BY TURBULENCE AND CLOUDS IN AN URBAN BOUNDARY LAYER
G. K. Greenhut (NOAA/ERL (R/E2), 325 Broadway, Boulder, Colorado 80303), J. K. S. Ching, R. Pearson, Jr. and T. P. Repoff

The turbulent fluxes of ozone and latent and sensible heat are computed from fast-response measurements made aboard a NOAA aircraft over downtown Philadelphia and the surrounding suburbs during the afternoon and evening of 22 August 1979. In the afternoon, the ozone flux at a height of 200 m is downward throughout the region with the largest magnitude (~2 (ppb) m s^{-1}) occurring over the urban center. During the afternoon at both 200 m and a few hundred meters below cloud base, the horizontal profile of mean ozone concentration peaks at 130 ppb over the urban core with values of the order of 90 ppb to the southeast and northwest. The urban ozone concentration at 200 m decreases to 35 ppb by early evening. The normalized variances and spectra of vertical velocity, temperature and ozone show little change with height or location in the urban center and northwest suburbs during the afternoon, in good agreement with normalized statistics obtained over rural terrain. Data from a cloud penetration by the aircraft is used to estimate a mean updraft velocity of 4.0 m s^{-1} and an updraft area of approximately 1 km^2. The flux of ozone due to the mean motion in the updraft is two orders of magnitude larger than the turbulent eddy fluxes within the cloud.
J. Geophys. Res., D, Paper 4D0184

3715 Chemical Composition and Chemical Interactions, Meteorology
NON-METHANE HYDROCARBONS IN REMOTE TROPICAL, CONTINENTAL, AND MARINE ATMOSPHERES
J. P. Greenberg (National Center for Atmospheric Research*, Boulder, Colorado 80307) and P. R. Zimmerman

Atmospheric hydrocarbon measurements from remote areas are presented and analyzed to determine sources of ambient mixing ratios. Biomass burning appears to make major contributions to free tropospheric hydrocarbon burden over tropical forests and grasslands. Biogenic emissions constitute a large percentage of the atmospheric hydrocarbon volume in continental areas of significant productivity. In marine areas studied, ambient hydrocarbons may include contributions from evaporation of dissolved hydrocarbons transported by ocean currents from areas of coastal upwellings or marine pollution. In all cases, hydrocarbons from local sources are major components of the atmospheric hydrocarbon composition. (Hydrocarbons, continental, marine, tropics).

*The National Center for Atmospheric Research is sponsored by the National Science Foundation.
J. Geophys. Res., D, Paper 4D0087

3715 Chemical Composition and Chemical Structure
STRATOSPHERIC ODD-NITROGEN: MEASUREMENTS OF HNO_3, NO, NO_2 and O_3 NEAR 54°N IN WINTER
B.A. Ridley (National Center for Atmospheric Research, Boulder, Colorado, 80307), Son Ha Luu, D.R. Hastie, H.I. Schiff, J.C. McConnell, W.F.J. Evans, C.T. McElroy, J.B. Kerr, H. Fast and R.S. O'Brien

Data obtained during three stratospheric measurement campaigns from Cold Lake, Alberta (100.0°W, 54.4°N) in February 1977, 1978 and 1979 are presented. Altitude profiles of NO, HNO_3, O_3, CFM-11, CFM-12, and H_2O and ground-based total column measurements of NO_2 were obtained and are compared to similar measurements made at 51°N in summer. The winter data demonstrates enhanced variability when compared to summer conditions but in general in winter a) there is a greater abundance of HNO_3 and the stratospheric layer is thicker, b) there is less nitric oxide particularly in the 18-28 km region and the vertical distributions are characterized by strong mixing ratio gradients and c) the column abundance of NO_2 is lower and exhibits a diurnal change qualitatively similar to that observed in summer. The difference between the summer and winter observations are not solely due to changes in photochemistry but require consideration of stratospheric dynamics. We correlate the reduction in NO_x in winter with the production of N_2O_5 in regions of little or no insolation followed by transport to Cold Lake. The unusual profiles are shown to result from air masses at different altitudes having either different origins, e.g. polar or mid-latitude, or different transit times from the source to the sampling point. (Nitrogen oxides, seasonal distribution, stratospheric chemistry).
J. Geophys. Res., D, Paper 4D0089

3720 Climatology
THE ORIGIN AND EARLIEST STATE OF THE EARTH'S HYDROSPHERE
J. Graham Cogley (Geography Department, Trent University, Peterborough, Ontario, CANADA K9J 7B8) and A. Henderson-Sellers

The origin and earliest history of the Earth's hydrosphere – the excess volatiles defined by Rubey in 1951 – can be constrained by evidence from astrophysics and geology. Models for the evolution of the Solar System and for the growth of the Earth suggest quite strongly that the hydrosphere came into being during accretion. Its format, with H_2O mostly in the oceans, CO_2 mostly in sediments and a residual atmosphere dominated by N_2, CO_2 and H_2O, was established very early and has persisted without destabilizing climatic excursions. Alternative accounts of early history, in which the Earth either loses a massive primordial atmosphere or acquires its secondary atmosphere by gradual degassing, now seem improbable. It is difficult, for example, to dissipate a massive atmosphere in reasonable times, and gradual outgassing seems to be ruled out because accretion was a highly energetic process. Several geological isotopic systems which can be sampled today require early separation of the atmosphere, and probably the hydrosphere as a whole; these isotope systems also suggest an early origin of the biosphere. Geological indicators of atmospheric composition are also consistent with an early hydrosphere having an initial neutral or weakly reduced chemical character. Such a hydrosphere, warmed by a less luminous early Sun, appears to be climatically stable at surface temperatures close to that of the present day if the major hydrospheric constituent is liquid water. A near-global ocean and a cloudy atmosphere suffice to maintain stability against the perils of the "deep freeze" and the "runaway greenhouse". Large quantities of atmospheric greenhouse gases are not required for climatic stability, although CO_2 may well have been present in amounts larger than today; large expanses of dry land, however, difficult to accommodate in the picture which we present, but the continents probably did not differentiate until later in geological history. Localized glacier ice may have provided a milieu favourable for early chemical evolution.
Rev. Geophys. Space Phys., Paper [illegible]

3720 Meteorology (Climatology)
A MODEL OF OXYGEN ISOTOPE COMPOSITION OF PRECIPITATION: IMPLICATIONS FOR PALEOCLIMATE DATA
Curt Covey and Philip L. Haagenson (National Center for Atmospheric Research, P. O. Box 3000, Boulder, Colorado 80307)

[illegible]

3790 Instruments and Techniques
NIMBUS-EARTH RADIATION BUDGET SENSOR CHARACTERIZATION FOR IMPROVED DATA FIDELITY
R. Maschhoff (Gulton Industries, Inc., 6600 Gulton Court NE, Albuquerque, NM 87109), A. Jalink, J. Hickey and J. Swedberg

[illegible] environment, provide an [illegible] improved accuracy in the final data products. The characterizations included detailed FOV mappings, responses to transient long and short wavelength radiation, and response to sensor temperature changes. These sensor and environment characterizations, along with the outstanding low noise and stability properties of the ERB instrument signal processing system, promise to improvement of the data accuracy to levels sufficient for long term budget and climatological purposes. The combined data sets from Nimbus 6 and 7 are expected to span a period in excess of 10 years. The improvements in data accuracy are particularly significant over zonal latitude bands because the corrections are shown to be strongly latitude dependent. (Radiation budget, sensors).
J. Geophys. Res., D, Paper 4D0040

3793 General (Precipitation Patterns)
SOME FEATURES OF GROUND RAIN PATTERNS MEASURED BY RADAR IN NORTH ITALY
A. Pawlina (Centro Studi Telecomunicazioni Spaziali CNR, Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano)

The radar observations of rain during 1980 at Spino d' Adda near Milan provided a large data base composed of about 16,000 ground rain cells, collected at the low altitude of 1.5 km from the ground, and characterized by a reflectivity factor greater than 34 dBz. This collection of rain elements supplied some statistical information required for rain-attenuation modeling. Thus the point rainfall rate distribution as well as the cumulative distributions of maximum, mean and root mean square of rain rate referred to an individual rain area (cell) were found to be power-law functions of the rain rate. The probability distribution of the linear extent, D, of a rain cell with a given rain intensity, R, exceeded over the cell, was found to be an exponential function of D, while the probability distribution of cells with a given size, D, to be related by a power-law function to the rain rate exceeded in the cell. The empirically derived formula for estimating the absolute probability of a rain cell with a given intensity and size is proposed and found adequate for the observed region and period. (Rain cells characteristics, rain-attenuation modeling).
Rad. Sci., Paper 4S0134

3799 General (Numerical Weather Prediction)
PREDICTION EXPERIMENTS WITH SEASAT-A SCATTEROMETER DATA
W. E. Baker (Laboratory for Atmospheric Sciences, NASA/Goddard Space Flight Center, Greenbelt, Maryland, 20771), R. Atlas, E. Kalnay, M. Halem, P. M. Woiceshyn, S. Peteherych, and D. Edelmann

A series of data assimilation experiments is performed to assess the impact of Seasat-A satellite scatterometer (SASS) wind data on Goddard Laboratory for Atmospheric Sciences (GLAS) model forecasts. The SASS data are dealiased as part of an objective analysis system utilizing a three-pass procedure. The impact of the SASS data is evaluated with and without temperature soundings from the NOAA-4 Vertical Temperature Profile Radiometer (VTPR) instrument in order to study possible redundancy between surface wind data and upper-air temperature data.

In the Northern Hemisphere, the SASS data are generally found to have a negligible effect on the forecasts. In the Southern Hemisphere, the forecast impact from SASS data is somewhat larger and primarily beneficial in the absence of VTPR data. However, the inclusion of VTPR data effectively eliminates the positive impact over Australia and South America. This indicates that SASS data can be beneficial for numerical weather prediction in regions with large data gaps, but in the presence of satellite soundings the usefulness of SASS data is significantly reduced.
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4215 Circulation
[illegible]

Loop Current in the fall of 1980 and moved into the western Gulf of Mexico. [illegible] obtained from satellite-tracked drifters show that typical speeds of the near-surface currents associated with this ring are about 50 cm/s. There is also a surprising amount of higher frequency current fluctuations. These include diurnal and semi-diurnal tides, a basin tidal resonance, and a free gravity mode.
J. Geophys. Res., C, Paper 4C0115

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[illegible]

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